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NATURAL HISTORY

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NATURAL HISTORY

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Australia and Asia

NATURAL HISTORY FOR JANUARY-FEBRUARY, 1924, will be devoted predominantly to **Australia,** the fauna, the flora, and the anthropology of which have a unique interest. Australia is the land of living fossils. There, and in no other continent, are found the egg-laying monotreme mammals, the lowest division of the Mammalia; there the marsupial mammals, represented not only by the familiar kangaroo but by flesh-eating members of the group, flourish as they thrive nowhere else in the world; there the placental mammals, the group which we who live in another part of the globe think of as the mammals *par excellence* are exclusively later-day invaders.

Hardly less interesting than the mammals of Australia, living and extinct, are the birds and the reptiles.

Just to the south of Australia lies Tasmania, where until recently lived the most primitive representatives of modern man, so lowly in physical type that like the mammals of the region they must be regarded as something that has persisted from a remote past, a past that has been largely effaced in other parts of the world.

The American Museum's interest in Australia has been a keen one. In May, 1921, a Museum expedition, consisting of Dr. William K. Gregory and Mr. Harry C. Raven, sailed for that continent, where collecting was in progress until February, 1923. In addition to specimens obtained in the field, a number of exchanges have been consummated with museums in Australia, so that the American Museum is in a position to install in the not distant future an Australian exhibition that will give the visitor a representative picture of that land.

In the January-February number of NATURAL HISTORY Doctor Gregory will describe the character of this exhibition, Mr. Raven will tell of the work done by the expedition, while several of Australia's foremost naturalists will deal with different divisions of their country's wonderful wild life.

THE MARCH-APRIL NUMBER will be devoted to **Asia,** especially to the THIRD ASIATIC, FAUNTHORPE-VERNAY, and SIWALIK HILLS EXPEDITIONS.

THE RHINOCEROS IGUANA GROUP

This group of *Cyclura cornuta* recently placed on exhibition in the American Museum represents the home life of the most powerful lizard in the New World. The species frequents the desert areas of Santo Domingo. The scene represented is the western shore of Lake Enriquillo, a dead sea more than 130 feet below the surface of the ocean

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Trailing the Rhinoceros Iguana

HOW THE FACTS PRESENTED IN THE GROUP OF THESE REPTILES RECENTLY INSTALLED IN THE AMERICAN MUSEUM, WERE OBTAINED IN THE FIELD BY THE ANGELO HEILPRIN EXPEDITION

By G. KINGSLEY NOBLE

Associate Curator of Herpetology (In Charge), American Museum

This group of *Cyclura cornuta* recently placed on exhibition in the American Museum represents the home life of the most powerful lizard in the New World. The species frequents the desert areas of Santo Domingo. The scene represented is the western shore of Lake Enriquillo, a dead sea more than 130 feet below the surface of the ocean

BLANCHED cliffs of jagged corals shut in on both sides the viscid waters of Lake Enriquillo. Under the dazzling glare of a Dominican sun these waters have gradually evaporated, turning first from a brackish solution to a brine, leaving behind miles and miles of scorching *saladas* (salt plains) to dance in the broiling heat. When the sun has reached its fullest intensity, great, dark-skinned lizards here and there slide out from the tunnels which they have clawed through these cliffs of coral limestone. Wagging their ponderous heads in mechanical-toy fashion, they gaze with seeming contentment upon their desolate world.

A portion of this region has been represented in the rhinoceros iguana group recently placed on exhibition in the American Museum, for it was in the vicinity of this shrunken Lake Enriquillo that the Angelo Heilprin Expedition first went to hunt these powerful saurians. Although fully equipped and provided with two Ford cars, the expedition required a month of the most difficult traveling to capture the specimens exhibited and to ferret out the secrets of their strange life.

During a part of the Pleistocene, this whole region was under the sea. A great arm of the ocean then separated southwestern Haiti from the rest of the island. Corals and sea fans vied with mollusks and tropic fish in splendor and brilliancy of color. Later came an orogenic movement which cut off the strait from its mother ocean and transformed it into two large lakes, —Enriquillo to the east and Saumâtre to the west. Mountain streams poured fresh water into these lakes; the sea life died. With the tropical sun beating down from overhead, the water gradually receded, leaving the skeletons of dead sea creatures ghastly white on the parched plains.

This region has been a valley of death ever since man can remember. At first avoided by the Indians because of its sterility, it later became a refuge for natives that had escaped from their Spanish masters. At one time, six hundred such fugitives gathered about the lake, and under the wise guidance of their chieftain Enriquillo, defied the Spanish for many years. At length a treaty was made and the district turned into an Indian reservation, soon to be destroyed by Spanish treachery.

Today a few natives still gain their living near the mountain streams which flow into these ever-receding lakes. One of the largest of these settlements, known as Duvergé, had been selected as our first base in the search for the rhinoceros iguanas. Toward this village, accordingly, we directed our two Fords one September morning in 1922.

In these small outlying settlements

[1]Photographs by G. Kingsley Noble and Ruth Crosby Noble

the most influential man is apt to be the one with the blackest reputation. In Duvergé the village chief was an Armenian ex-bandit who had adopted the name of Juan Herrera. In the neighboring town of San Juan, the rôle of leader had been assumed by "Papa Lavoria." The latter, dressed like a Zouave, had instituted a religious sect, and had won sufficient fame to have a brand of rum named after him. Although the U. S. Marines had come to Santo Domingo to drive out the bandits, they could not do so if the latter happened to be the leading citizens. The next best thing was to make friends with these marauders of high station, and try to reform them. "Papa Lavoria" would not reform. His crimes continued until he was finally shot in attempting a bold getaway. With Juan Herrera diplomacy had worked better. Instead of going in for religion, he went in for Americanism as he conceived it and adopted all the trappings of civilization which went with it. Drawing upon his treasure chest he bought a straw hat, a Ford car, and even set up an electric light plant in his *hacienda*. The Marines wisely gave him an official title and let him wear a revolver. The added prestige delighted Juan. He set aside his best thatched hut as quarters for visiting Marines or for their American friends. Hence it came about that we were to be his guests while at Duvergé.

Enriquillo, the dead sea.—No life can exist here except where some mountain stream has worked its way across the scorching plains to mingle with the saline waters. The feral pig in the distance has been startled by the approach of members of the Heilprin Expedition

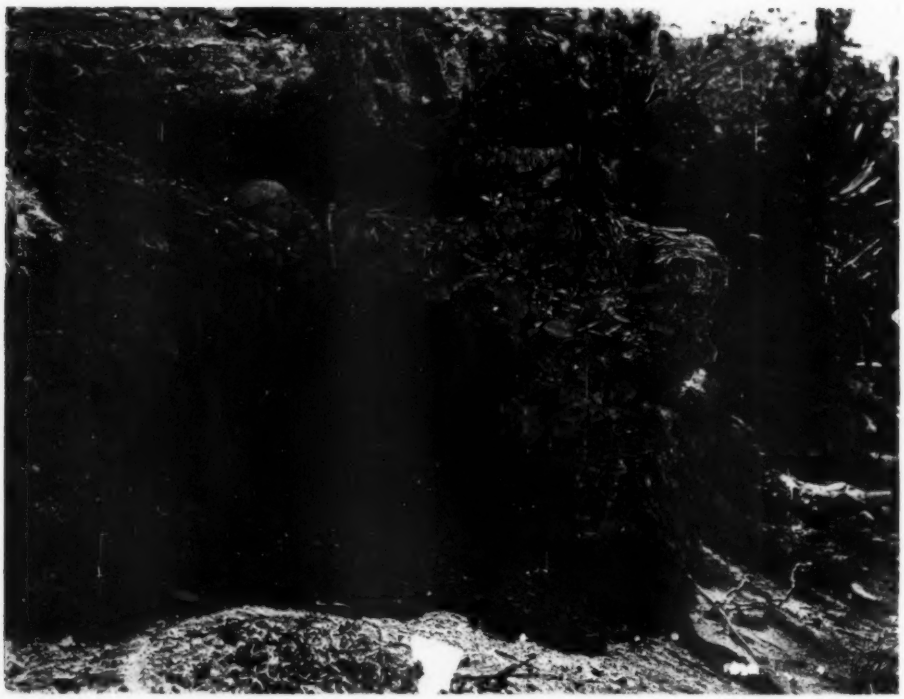
Duvergé proved to be a scattering of dingy huts staggering about without reason on the arid plain between Lake Enriquillo and the Sierra de Bahoruco. The enormous load of palm thatch which smothered each hut served as an index to the terrific heat we were des-

Duvergé, at the foot of the Sierra de Bahoruco, was made the first base in the hunt for the rhinoceros iguana

The customs house near Las Lajas on the Haitian-Dominican border, one of the few well-built houses in this region, was devastated by bandits in 1919 and has remained in ruins ever since

tined to withstand during the following weeks.

The morning after our arrival we went with two guides into the hills a few miles away. Ashy forests of cacti and tamarind growing in dense profusion in the valleys crowded against the base of these hills, but the rugged



The home of the rhinoceros iguana on the western shore of Lake Enriquillo. The burrows are clawed through fossil corals sometimes for a length of forty feet

slopes were only sparsely clothed with vegetation. One of the guides took the lead and without looking to right or left moved swiftly across the hills in a westerly direction. In this desert region of Santo Domingo the rains fall only during a short season, but then the downpour is so violent that it carves deep chasms in the hills. These the natives call *arroyos* (streams), although they are dry throughout most of the year. As I scrambled along over the hills, I felt myself gradually wilt. Dark blotches of perspiration spread rapidly over my khaki trousers. My leather putties turned from tan to nearly black and began to droop in soft, damp folds about my ankles.

We came at length to the brink of one of those dry *arroyos*, one that was a little dustier and more stifling than the others. The acacias which had once grown here had been scorched out of existence, leaving only their gnarled roots to twist and writhe among the sun-heated limestones. Here and there little clumps of organ cacti had survived by drawing close together, like so many soldiers withstanding a final attack. The guide had stopped and was pointing at something far up in the cañon. At first I could see only the twisted roots of the dead trees. Gradually there took shape in the shadow of one of the larger trunks the crest of a rhinoceros iguana. Slowly the beast raised itself. His deep-set eyes stared coldly in our direction. I noted that he was directly in front of a jagged burrow and quietly I slipped my heaviest charge into the breech of my shotgun. Slowly the stock came to my shoulder: a terrific report echoed through the cañon. The lizard reared, then dropped

down the burrow. We rushed up the bank and tried in vain to dig him out.

Next morning we came back with pick and shovel. The burrow went in 13½ feet, gradually turning to the right. At the end was a chamber three feet square and about 1½ feet high. But there was no sign of the iguana. The wounded lizard had obviously escaped during the night.

For a week we searched these cañons. We found that the rhinoceros iguanas dug their burrows only in the stony cliffs or in the vertical walls of occasional sink holes,—never in the sandy *playas* which stretched for miles and miles on all sides. With native help we rounded up a number of half-grown iguanas, but the large ones always escaped us.

As it became more and more doubtful whether we would secure any large specimens, some of the natives came to us and said that out in Lake Enriquillo there was an island abounding in gigantic iguanas. To be sure, no one had been to the island for twenty years. Enriquillo was a dead sea and there were no boats on the lake. In fact, there was no need for boats, as fish did not exist in water 50 per cent more saline than the ocean.

A few days later, however, the town of Duvergé was startled by the sight of a boat carried aloft on a Marine Corps's truck through the heart of the village. Our host, Juan Herrera, was particularly excited and immediately organized a party to assist in exploring the iguana island. Early on the mor-

At home,—a detail from the Rhinoceros Iguana Group (frontispiece). Most of the cliffs which border Lake Enriquillo have a similar composition of fossil corals and shells

To reach Enriquillo the boat had to be dragged across miles of *salada*,—soft, salt-streaked mud, fissured with sun cracks having a regular polygonal form

The unfrequented island in the lake proved to be a great sand flat adorned with enormous candelabra-like cacti

row eight pairs of hands dragged the boat across the two miles of quaking mud that separated the terra firma from the water's edge. The boat would hold only four and it was decided to take Juan, a guide, Mrs.

Noble, and myself. Four miles of open water stretched between the island and ourselves. A strong wind had already sprung up and the waves washed dangerously close to the gunwale of our little craft. I took the oars and had made perhaps a mile when suddenly a great black snout arose from the green waters and shot out ahead of our bows. It was a crocodile perhaps twelve feet in length. The waves striking on his muzzle broke into spray, which glistened in the sunlight. A crocodile in a dead sea, landlocked, and separated from the ocean by forty miles, must lead a precarious existence. Surely he must be very hungry!

Two hours later we reached the island. It was a long sand spit twelve miles in length by a mile in width. Strange candelabra-like cacti confronted our eyes on all sides. As we moved inland, there was a rush and four grotesque saurians charged out from under some fallen cacti. Before they disappeared I noted that they lacked the tusk of the rhinoceros iguana but were equipped instead with numerous whorls of spikes on the tail. They were, in fact, a different species—*—Cyclura ricordii*—and one that had been lost to science for more than fifty years. We soon found that these lizards were everywhere on the island. Unlike the rhinoceros iguanas, they dug holes into the flat salt-encrusted playas. Of the rhinoceros iguana we could find no trace. After hunting a half day we gave up and went back to the boat.

By this time the dead sea had become lashed into a mass of whitecaps. Dominicans are traditionally poor sailors and Juan was eager to remain overnight on the island, hoping to venture across when the wind abated. But our friends were waiting expectantly for us on the other shore and so at last we started. The wind continued to rise. The guide and I steadied the boat with our oars. Wave after wave came over the gunwale. Mrs. Noble bailed frantically while Juan hung limply over the side of the boat. In spite of our shouts "*Saca agua!*" Juan remained motionless until the guide reminded him of the crocodiles when he recovered his vitality with startling suddenness. It was soon apparent we could not make the opposite shore, and it was equally dangerous to attempt a return to the island. While Juan alternately swore and prayed, we began to drift straight down the lake with a distance of more than ten miles between us and the lee shore. Four hours later our boat—half full of water—scraped bottom just off a beach. We all jumped out and pulled our specimens clear of the tumbling waves. It was now dark and we had drifted many miles from any habitation. In true bandit fashion Juan lit a fire, and the guide after much grumbling started out in search of the Fords.

A few days later we gave up our search for adult iguanas in the vicinity of Duvergé and struck out for Lake Saumâtre on the Haitian border. It was long after dark when we reached Las Lajas, the last Dominican outpost. In the dim light of Guardia lanterns the half dozen hovels that form this settlement seemed untenable. We were directed with much ceremony to the *casita* of Roque Valdez,—the customs officer and first citizen of the town. It was a dingy hut of three rooms, palm-thatched and adobe-walled, yet the elaborately embossed rum glasses on a massive table were obvious indications that we were in the home of a

The rhinoceros iguana (*Cyclura cornuta*), the largest of the rock iguanas.—It was primarily to work out the life history of this saurian that the Angelo Heilprin Expedition went to Santo Domingo

gentleman. Dinner had already been prepared for us. With surprising relish I consumed my share of burned goat meat, fried plantains, and fresh papaya, then leaned back to take a look around. There at my feet, staring up with eyes of hunger, was the leanest yellow dog I had ever seen. How a hungry dog can stare! The rind of my papaya was still on my plate. Just to avert the stare of those eyes I dropped the scarcely edible portion upon the clay floor. A snarl, a few gulps, and the rind had disappeared.

The island which we had selected for our hunt in the morning, though not indicated on any map, is nearly a quarter of a mile long and a hundred yards wide. In all our iguana hunts, when we wished to capture the beasts alive, dogs were essential. Various natives had promised me hunting dogs that morning, but of course they did not appear. In my dilemma I came to

The Dominican spike-tailed iguana (*Cyclura ricordii*).—This huge saurian is found in the same region as the rhinoceros iguana, but has very different habits. The photograph was made on the island in Lake Enriquillo by stealthily approaching a wild specimen

think of the lean yellow dog with the terrible appetite. "Was the little dog a hunter? What was his name?" Roque only shook his head and said, "*No ser-vee, no ser-vee*"—a corruption of *no sirve*, meaning good for nothing, and implying that the dog did not deserve a name. Most Dominican dogs are brought up to chase pigs or goats. The yellow pup had apparently not proved very valuable and had therefore become the object of many a blow, a slinking shadow in the home of Roque Valdez. Yet this morning any dog was better than none and the worst was worth a try-out. So it came about that "No Ser-vee" became a member of our party.

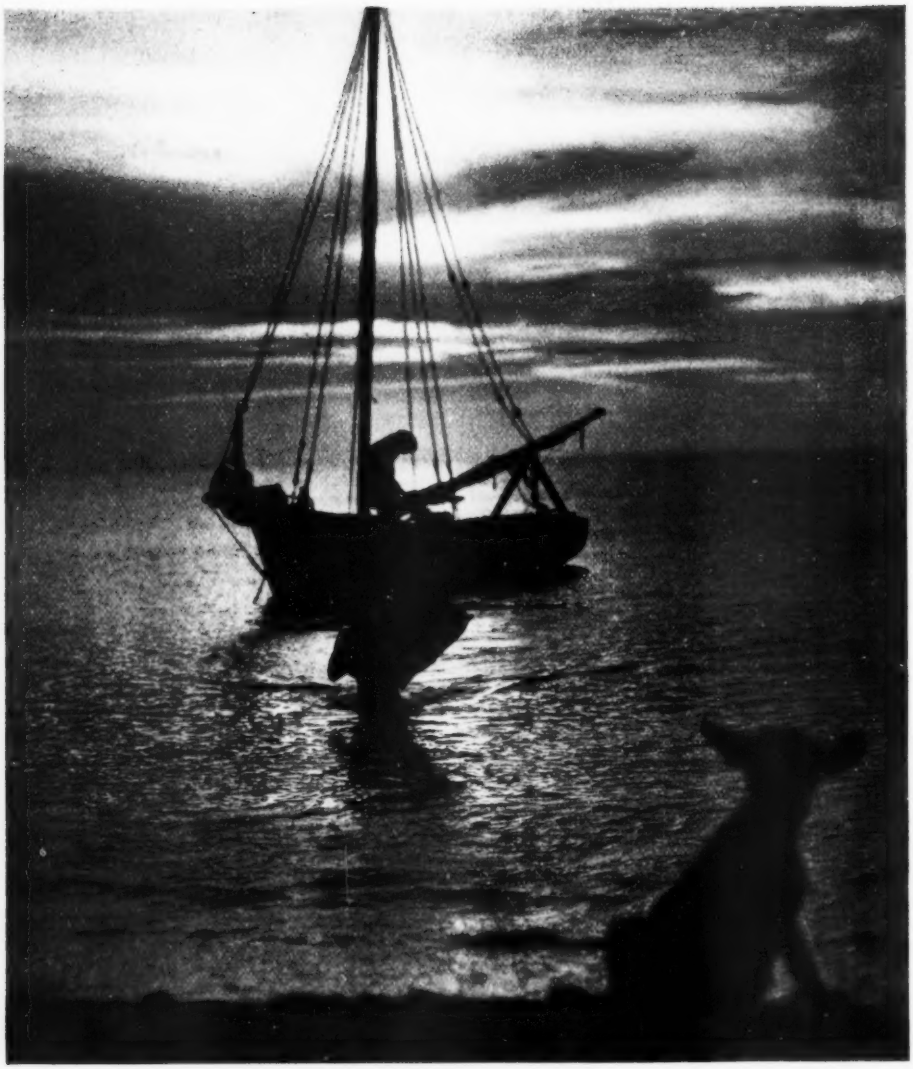
Just as we were loading our equipment on to the small boat we had brought with us, two Haitian boys came along with a second yellow dog, this one slightly larger and more muscular than Roque's. The boys gave us

MORNING OFF THE COAST OF SANTO DOMINGO

It was on Beata, an island off the coast, that the expedition secured the final details of the life history of the rhinoceros iguana

"BATÉ 6"

The desert east of Barahona has been marked up into *batés* (an Indian word for yards) and one of the largest sugar companies in the world hopes to secure by irrigation a continuous production of sugar throughout the year. With Haitian labor enormous stretches of country have been cleared of their cacti and scrub, and much cane is already being grown. The great bonfire shown in the picture consumed a quarter of a mile of brush



The "Mayflower" at anchor off Beata.—An iguana hound kept watch while the men unloaded the boat in preparation for a hunt on the morrow

to understand that this dog was especially trained to hunt iguanas, for on the Haitian side of the island these lizards are highly prized as food.

An hour later the boat grated on bottom close to the island, and dogs and blacks scrambled pell-mell across the few yards of glaring limestone to a forest of cacti that covered the central core. In a moment all had been swallowed up by the brush and the gray streamers of Spanish moss which swung from the cacti. Separated from the party, I picked my way alone through the forest toward a ridge, the outer edge of this rugged island.

Suddenly a dog's yap broke the silence, followed by a rattle of short barks. There was a scramble, and then an iguana—mouth agape—shot from

the brush, with the "Good for Nothing" dog close at his heels. The reptile turned at bay a yard from the water but the little dog dove at him. Another scurry, and both dog and iguana splashed into the water. The little dog came out as quickly as he went in and stood shaking himself with his tail between his legs. Most yellow dogs are not very heroic in appearance, but when such a dog is very thin and very wet, he excites only pity. Of the iguana nothing was to be seen. Had the reptile been swallowed up by the lake? These saurians live their whole life on land, emerging from their burrows only when the sun is shining brightly. Heat and drought seem essential to their livelihood. They avoid regions of luxuriant growth, or even of moderate humidity, preferring always the sun-baked rocks and scrub of the bad lands. The iguana must surely be drowned, I thought, when after nearly five minutes of patient waiting, there was still no sign of him. Just then a dark object rose slowly toward the surface. Stiff as a bar, and nearly vertical in the water, the iguana was cautiously seeking air. Hardly had the horned snout cleared the surface, when the reptile saw the two excited dogs and the four humans gazing at him. With a gulp he dove again into the blue depths of the lake.

These singular actions made clear to me a problem which had long been a puzzle. Why is it that many of the West Indian islands which are supposed to be volcanic in origin,—to have arisen from the depths of the sea,—are, notwithstanding, peopled by reptiles and amphibians that are never known to approach the sea and hence could not have been carried from the mainland by accident? Here in the case of the iguana we had an explanation. Although the iguanas in their ordinary round of existence avoid the sea, nevertheless, when thrown by accident into it, they are perfectly at home. Potentially they are water reptiles, even though the daily exigencies of life do not call forth any contact with the ocean. While I was thus musing, one of the Haitian boys had stripped off his clothing and plunged into the lake. A shower of spray, and the boy emerged holding the iguana firmly by the neck. A pair of outstretched hands relieved him of the prize and nimble fingers tightened cords about the booty.

The days that followed yielded other iguanas. Our pack now included many dogs and these hunted well. Each sweltering chase added a little to our growing information regarding these reptiles. Their food habits, the places where they occur, the form of their burrows,—all had to be determined. But while these problems were soon solved, some of the most important questions remained unanswered. Where did the iguanas lay their eggs? Why had we secured no very large specimens? In desperation, we changed our hunting grounds again, first returning to the coast with the specimens we had secured.

Back in Barahona the Marines turned the barracks over to us in which to house ourselves and the iguanas we had taken alive. We tied up the thirty or more captives to the springs of the cots. There they stood solemn and statuesque, peering with sullen dignity at those of the passers-by who cautiously kept their distance, and offering a warning gurgle to the more curious. Bananas were placed before the creatures and these they devoured at a gulp.

At night uncanny sounds arose from the thickets: the hermit crabs of the seabeach were climbing trees in search of prey

At last, with only a couple of weeks left before the boat would arrive that was to take us and our captives back to New York, we decided to make one last effort to find the eggs. A Marine had told us that far down the coast on a little islet called Beata (the blessed one) he had seen iguanas "as big as crocodiles." Not knowing where else to turn, we engaged a little sloop—the "Flor-de-Mayo" ("Mayflower") and the last day of September started out to sea with five men and the two yellow dogs we had brought from Las Lajas. By dusk of the following evening we dropped anchor in a cove on the west side of the island.

Beata is a triangular block of eroded limestone about seven miles in length. Its leeward, or westerly, part is densely covered with a tangle of cacti and bush, while its eastern arm is almost devoid of any cover. Although no one lives on the island, turtle fishermen occasionally stop there and on

The expedition joined forces with a band of pig hunters

rare occasions some hunters come to seek the goats and pigs which have run feral there for many years.

It so happened that one of these hunting parties had just landed on the island. That night we joined forces and thus added six dogs and three men to our iguana party. We were a strange group seated about the camp fire. Half the men were stripped to the waist and all save my two Guardia wore machetes, which shone blood-red in the light of the camp fire. Gradually, above the voices of the men I made out a dry, rustling sound, a crawling noise, as if someone were dragging dead bones out there in the darkness. I seized my hand lamp and shotgun and tiptoed out of the circle. Now the sound came from above my head. My electric light flashed upward, cut a great hole in the blackness. Numerous white balls were moving in every direction up and down the trees. I drew nearer and found—the last thing I would have expected—hermit crabs, usually to be seen only between the tide lines, here clambering noisily over the branches, carrying their shell houses with them.

Next morning we waited until the sun was well up and then started out in a body. We had gone only a few steps when, with a yelp, the dogs started something. It proved to be an enormous iguana, which easily waded through the pack and disappeared down a burrow. Then a strange thing happened. The little yellow dog we had brought with us from Las Lajas, the one that had been considered useless by Roque Valdez, plunged headlong down the burrow after the iguana. His barks became less and less audible as he went deeper into the ground. The natives were now very excited. It was impossible for the little dog to pull out the iguana, and they all began to shout "*Viene p'au, viene p'au.*" But the dog paid no attention. The barking grew weaker and weaker. Then suddenly a shrill yelp arose from the depths, and the little dog came charging out—dripping with blood. He had been badly bitten in the head. We hastened to bandage him up, and at last sent him back to camp with one of the men.

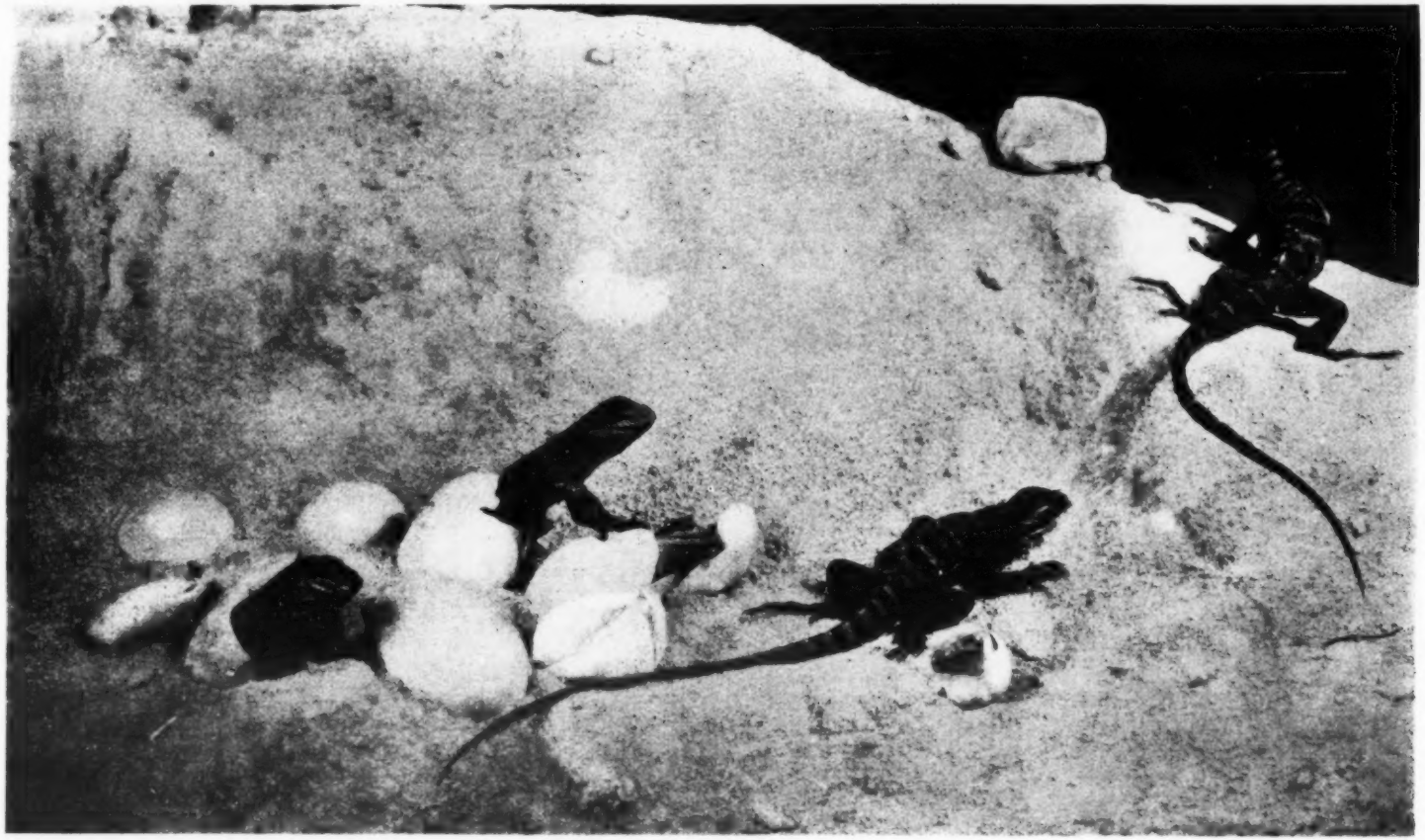
A short distance beyond we came to a little clearing. To the seaward side was a great pile of conch shells, each shell very much weathered but showing the round hole made by some Carib fisherman when cutting out the mollusk. This was obviously the camp site of an ancient Indian settlement. I began to inspect the ground closely and came at length upon some broken eggshells. They were larger than chicken's eggs, but shrivelled and leathery in appearance. They could not be turtle eggs, for most of these have hard shells like those of a chicken. Could they be iguana eggs? Manuel was on his knees and digging. He was nearly down to his arm-pit when he abruptly jerked up and there in his hand was a tiny iguana in the very act of hatching from an egg.

Leiocephalus beatanus, one of the four species of lizards new to science which came to the camp at Beata

THE DISCOVERY OF THE IGUANA EGGS

Damp sand and broken eggshells, shrivelled in appearance, suggested that young turtles or other reptiles might have recently hatched.

Manuel began to dig and soon found five nests containing these eggshells—a few with hatching rhinoceros iguanas



HATCHING IGUANAS

Some of the little iguanas pull their eggshells with them as they wriggle through the twenty inches of sand which covers them. Most of them, however, leave their shells behind and give no clew to the spot where their mother deposited her clutch of seventeen eggs nine weeks previously. Detail from Rhinoceros Iguana Group (frontispiece)

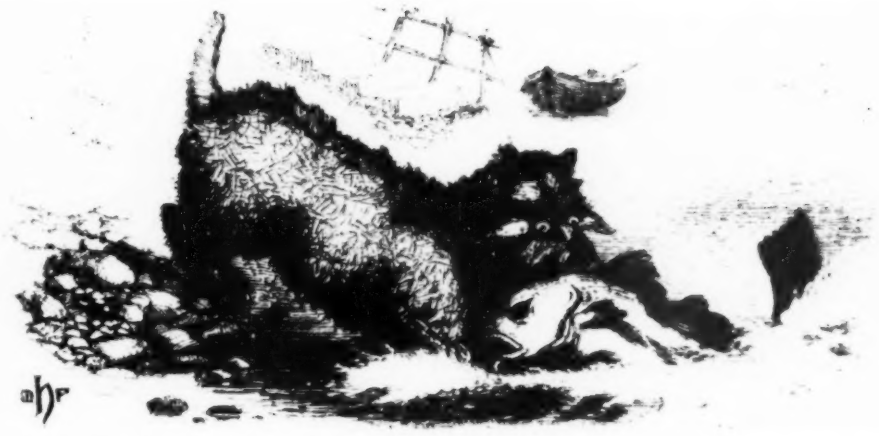
We now began digging everywhere in the sandy clearing. In a space 150 × 70 feet we found five nests. Obviously, the iguanas were somewhat gregarious during the breeding season. This was of special interest, for the rhinoceros iguana is supposed to be related to the Central American iguana, which is known to dig holes in sandy areas similar to the one we had just discovered. But the Central American iguana has gone one step further in its gregariousness: the females frequently lay their eggs in the same hole, until there may be more than ten dozen in a single pile.

Not only the nests but the young also gave us a clew as to the relationships of the species. The young had pale eyes and fleshy mouth parts similar to those of some of the less specialized rock iguanas. Furthermore, the young were cross-barred with black very much in the manner of certain species of "black" iguanas (*Ctenosaura*).

While we had been digging, the rest of the party had been scouring the thickets and before noon the men returned carrying two iguanas much larger than those we had seen before, though hardly the size of crocodiles.

That night the crawling sound of arboreal hermit crabs sounded almost joyful to me, and the bats as they whirred through our *rancho*, only a few inches above my face, seemed to understand something of our satisfaction in their island. The morning came and yielded not only more and larger iguanas, but additional data regarding the life history of these saurians. Four species of smaller lizards new to science were captured at the very door of our shelter. Beata, the unknown, was truly a reptilian paradise.

While the story of our group ends here, the story of the iguanas continues even as I write. More than forty were brought to New York alive and many of these were sent to Bronx Park. The keepers of the reptile house were duly warned of the ferocity of these new arrivals. But Head Keeper Toomey tried the experiment of making friends with them. Within a few months one of the largest of the iguanas had been so won over by this show of good will that when Mr. Toomey entered the cage, he would jump playfully on his knee like a kitten and look this way and that in an almost affectionate manner. After my weeks of chasing and fighting the iguanas in the field, this performance seemed almost incredible. But more surprising still was the change of food habits which Mr. Toomey induced. I had proved that the creatures were purely vegetarian in nature. One day at the Park when the supply of bananas was low, Keeper Toomey gave the iguanas some mice. These they seized quickly, shaking them as a cat might do, and immediately engulfed them in their great jaws. From these experiences it would seem that the rhinoceros iguanas are among the most changeable of reptiles. We had believed them terrestrial and they convinced us that they are at home in the water; we had thought them ferocious and they revealed themselves as affectionate; we had proved them, as we thought, to be vegetarians and they demonstrated to us that they could stalk mice in a most un-reptilian manner.



This picture of a Scotch terrier pulling out of the water a live cod that he has caught is reproduced from a volume by Cornwall Simeon published in 1860 under the title of *Stray Notes on Fishing and Natural History*. Every afternoon this dog would take his stand on certain stones that served as a landing place and wait until the approach of a fish enabled him to make a capture by a swift and accurate plunge upon his prey

Dogs as Fishermen

By E. W. GUDGER

Associate in Ichthyology, American Museum

THE wild Canidæ seek their prey in the woods and fields and many tame dogs still do so to some extent. However, early in the long course of his evolution from the status of cave dweller, man tamed the wild dog, and today brings him up as a household animal. And so artificial are some of our modern breeds of dogs, that if they were left free in a wood well populated with rabbits, they would inevitably starve.

Now, if dogs originally hunted for themselves, if they have been trained to retrieve ducks shot in a pond, and to hunt in the water such water animals as otters, then may they not be expected in some instances and under certain conditions to seek their prey in the water, to fish for themselves? A number of accounts of such activities have come to hand and will be set forth herein. These accounts may be divided into three categories: first, where dogs fish for themselves to obtain food; second, where they fish for sport; and third, where they assist men in fishing.

If dogs ever fish for themselves, one would expect them to do so either where there is practically no other food obtainable, or where fishes are more abundant and more easily caught than any other kind of food. First, then, let us go to the low-lying coral atolls of the South Seas where the birds of the air or the fish in the sea furnish practically the only edible food for dogs; where the inhabitants subsist almost wholly upon the fruits of the coconut palm and *Pandanus* and upon fish. Here the dog (primarily a carnivorous beast) must eat fish or die, and here he must often make his own catch, for his master has frequently enough to do to fish for himself and his family.

At Rutiaro atoll in the Tuamotu, or Low Archipelago, Hall and Nordhoff[1] tell us that they "watched a group of Rutiaroan dogs in their search for food. They had developed a sort of team work in the business, leaping toward the shore all together with a porpoise-like curving of their bodies, and were as quick as a flock of terns to see and seize their prey." Furthermore, one of these dogs, the best fisher on the island, always brought his capture to his master to be cooked and would not eat it until it had been cooked.

St.-Johnston[2] likewise records a similar habit of a dog at Loma-Loma in Lau, an island lying between Fiji and Tonga. This dog was once seen standing waist-deep in the water and snapping at something that was passing. Investigation showed that she was catching fish as they swam by in a shoal. She afterwards became a very keen devotee of fishing, changing fishing grounds with the tides and currents. She likewise trained one of her puppies, who shortly became quite as expert as his mother, often "edging her off his own private fishing-ground when the fish happened to be scarce."

In Siberia, at the season when the salmon are ascending the streams, the dogs find it much easier to catch fish in the water than to seek prey in the woods. I have in times past seen a number of references to this fishing habit as exemplified by the dogs of that region, but unfortunately only two instances have been preserved. Roulin[3] says that in Kamchatka during the summer the dogs, which throughout the remainder of the year are fed mainly on dried fish, vary their food by catching their own fish fresh from the water, wading in belly-deep to do so.

Roulin does not indicate the source of his data, but it seems probable that his informant is Langsdorff,[4] who, in that part of his travels, dealing with Kamchatka, gives a whole chapter to "Kamschadale Dogs." Concerning their food he says that:

> In summer they [the dogs] are generally left to rove at large, and find their own food, when they keep on the seashore, or in the neighborhood of rivers lurking after fish, standing in the water up to their bellies: when they see a fish they snap at it with such a certain aim, that they rarely miss it: in doing this their whole head is frequently under the water. When they can get a superabundance of food, as for instance, at the time when the salmon come up the rivers in shoals, they eat the heads only, as being the finest flavored part of the fish, leaving the bodies to become putrid.

Similarly Guillemard[5] writes of a sledge dog that being "a good hunter and fisherman, he supports himself upon the game and salmon he catches." He also tells how a particular dog, named Verglaski, would wade out into a stream, filled with salmon living and dead, and watch for a good, active, "clean" fish. This he would catch and retiring to the bank would eat. The half-dead fish (easy to catch) he would totally disdain.

In a part of the world far removed from either of the above-mentioned regions, both in space and physical conditions, namely in Egypt, dogs have a hard time getting a living. Food being lacking on land, they are forced to turn

[1]Hall, James Norman, and Nordhoff, Charles Bernard. *Faery Lands of the South Seas.* New York, 1921, pp. 126 and 142.

[2]St.-Johnston, T. R. *South Sea Reminiscences.* London, 1922, pp. 205–06.

[3]Roulin, F. *Histoire Naturelle et Souvenirs de Voyage.* Paris [1865], pp. 85–6.

[4]Langsdorff, Georg Heinrich von. *Bemerkungen auf einer Reise um die Welt in den Jahren 1803 bis 1807.* Frankfurt-am-Mayn, 1812, 3 vols.—English version. *Voyages and Travels in Various Parts of the World in the Years, 1803, 1804, 1805, 1806 and 1807.* London 1814, 2 vols., Vol. II, Chap. 14, p. 277.

[5]Guillemard, F. H. H. *Cruise of the Marchesa to Kamchatka and New Guinea.* London, 1886, Vol. II, pp. 82, 123.

to the water. "Fluker," says[1] that numberless times he has seen the half-wild and half-starving pariah dogs fishing on the shores of the lakes of Egypt and the Suez Canal. He adds that a friend of his at Ismalia had a setter dog which became very expert at catching mullets, which she promptly ate.

That dogs fish for sport, for the fun of fishing, may strike the reader as very unusual, but the testimony is clear and convincing. Chronologically the accounts are as follows.

Thomas Tod Stoddart[2] tells us that attached to St. Mary's Loch Club in Scotland was a dog, a cross between a collie and a Scotch terrier, which used to post itself on the shallow run between two lochs in order to watch the schools of perch which during the spring came in there to spawn. "And when an opportunity occurs, Gipsy will be observed to make a sudden dash towards the bottom with its head, and generally secures a fish, which it carries to land and forthwith kills." Furthermore, if an angler had trouble in landing a trout, the dog on command would plunge in and, seizing it in its jaws, would bring it ashore. Nevertheless, it would never eat a fish unless cooked.

In Yarrell's *British Fishes*,[3] 1836 edition, Volume II, page 56, there is quoted, from a manuscript left by Colonel Montague, the story of a water spaniel that caught all the carp in its master's ponds and because of its misdeeds was to be killed. However, a gentleman living some distance away, owner of a famous trout fishery, begged that the dog be given him, for he believed that such a wily and agile fish as a trout could not be caught by any dog. The spaniel, however, soon convinced his new master that even the trout were no match for him. What was then done with this troublesome fisherman is not stated.

Further, Yarrell in the second edition of his work (1841, Vol. II, pp. 69–70) quotes from a letter written by the Earl of Home to the effect that his uncle had a Newfoundland dog that became an expert fisher of salmon by attending the fishermen at work below a near-by mill dam. The dog used to take position at the opening in the dam made to allow salmon to ascend and catch them as they attempted to pass through. So skillful did he become that "he has been known to kill from twelve to twenty salmon in a morning," which he placed together on one side. And now follows a most interesting thing. It would seem that the dog was so successful that he actually threatened to diminish the supply of salmon in that stream, for we read that "The then Earl of Tankerville instituted a process against the dog. . . This case was brought before the Court of Sessions and the process was entitled 'The Earl of Tankerville versus a Dog, the property of the Earl of Home.' Judgment was given in favor of the dog."

The geologist, J. B. Jukes,[4] records the exploits in Newfoundland of a dog that evidently fished for the fun of it. We shall let Jukes tell his own story:

He [the dog] sat on a projecting rock, beneath a fish flake or stage, where the fish are laid to dry, watching the water, which had a depth of six or eight feet, and a bottom which was white with fishbones. On throwing a piece of codfish into the water, three or four heavy, clumsy-looking fish, called in

[1]"Fluker." *Fishing in Egypt*. Alexandria, [1918?], pp. 87-8.

[2]Stoddart, Thomas Tod. *The Art of Angling as Practiced in Scotland*. Edinburgh, 1835, p. 119.

[3]Yarrell, Wm. *A History of British Fishes*. 2 vols. 2nd Ed., 1841, Vol. II, p. 105; 3rd Ed., 1859, Vol. I, p. 283.

[4]Jukes, J. B. *Excursions in and about Newfoundland during the Years 1839 and 1840*. London, 1842, 2 vols. Vol. I, pp. 191–92.

Newfoundland "Sculpins," with great heads and mouths, and many spines about them, and generally about a foot long, would swim in to catch it. These he would "set" attentively, and the moment one turned his broadside to him, he darted down like a fish-hawk, and seldom came up without a fish in his mouth. As he caught them, he regularly took them to a place a few yards off, where he laid them down; and they told us that, in the summer, he would make a pile of sixty or seventy a day just in that place. He never attempted to eat them, but seemed to be fishing purely for his own amusement.

Jukes watched this dog for a couple of hours and noticed that when the fish became shy and did not come up, the dog would put his right fore foot (a white one) in the water and would paddle it about. Jukes' guide told him that the dog did this to "toll" or entice the fish. But our author was never able to decide whether this was so or was the result of impatience.

Cornwall Simeon[1] in 1860 relates, of a Scotch terrier attached to a shooting and fishing lodge in Ross shire, that above all things he loved to go out in the boats with the anglers, and that he always manifested the greatest interest in their catches. In the afternoon after the work of the men was over, the dog would do some fishing on his own account. Taking his stand on the large stones which served as a landing place, he would watch for codfish which came up seeking the offal that was thrown overboard after the day's catch had been prepared for the table. Simeon states:

Although he generally saw them when they were some little distance from the shore, yet if they seemed to be coming pretty straight towards him, he rarely made any demonstration until they were well within reach and he had a fair chance at them. Then he went in with a rush. There was a tussle, a diving, a gripping, and a blowing, and then gradually he emerged, struggling with and dragging after him the unwieldy and reluctant form of a big helpless-looking cod.

To the great disgust of the dog, his captures were, however, always thrown back. The keeper reported that the animal would also catch salmon in the same way. The picture reproduced on p. 559 of this article is from the titlepage of Mr. Simeon's book.

George R. Jesse[2] quotes as follows from an unknown writer in the *Sporting Magazine* concerning a dog which apparently fished for sport only:

A dog which, some years ago, was at the White Hart Inn at Salisbury [England], took his daily walk around the canal surrounding the Close, in search of minnows, which he seized with wonderful avidity. When few or none were visible he scratched up the gravel [in shoal water in the canal] for a considerable extent, and then patiently took his station till some unfortunate gudgeon came in sight [attracted by the freshly turned gravel], on whom he pounced with all the ferocity of a hawk secure of its prey.

Richard Jefferies[3] gives an interesting account, too long to be quoted verbatim here, of somewhat similar actions on the part of a pointer belonging to him. Some fish—roach, tench, perch, and a small jack—were kept for a time in a large stone trough from which cattle were wont to drink. After a time this trough became foul and while it was being cleaned, the fish were transferred to a large shallow tub. Here they were distinctly visible, and after watching them for some hours, the dog put her head under the water, removed them one by one and laid

[1]Simeon, Cornwall. *Stray Notes on Fishing and Natural History.* Cambridge [England], 1860, pp. 128–32.

[2]Jesse, George R., *Researches into the History of the British Dog*, etc. 2 vols., ills. London, 1866.

[3]Jefferies, Richard. *The Gamekeeper at Home.* 2nd Ed., 1880, p. 54.

them unmutilated on the grass. Jefferies put them back in the tub and watched the dog immerse her head and grope around until she found a fish; then out came her head and the fish was placed on the ground. This she did time after time and for fish after fish, the jack giving her the most trouble but eventually being always caught.

The next day she renewed her fishing exploits and soon became so expert that she did not miss a fish. When, however, these were removed to the deeper water of the trough, she no longer molested them as the trough was too wide and the water too deep for her unless she became completely immersed. No attempt was made to teach her; she acted throughout on her own initiative.

But some critic may object that these accounts are apocryphal or at any rate not attested by a naturalist of standing. To this it may be answered: in the first place, that these diverse accounts, spread over a number of years, coming from men who must be accredited as honest, are themselves corroborative and convincing proof; and secondly, that there will now be given an account from the pen of the veteran naturalist, W. H. Hudson, who tells of the following incident in his autobiography.[1]

It seems that, when a boy, he was one day on the water front at Buenos Aires as the tide was coming in. He noticed a man and dog approaching. Presently the dog left his master and bounding up to one of the outermost rocks, not yet washed over, where Hudson was standing, took position there and gazed intently into the water. "Suddenly he plunged in, quite disappearing from sight, but quickly reappeared with a big shad of about three and a half or four pounds in weight in his jaws. Climbing on to the rocks, he dropped the fish, which he did not appear to have injured much, as it began floundering about in an exceedingly lively manner."

The dog repeated this performance five times, evidently for the mere sport of the thing as his master paid no attention to him. The rising tide washed the fish back into the water, and by and by the man whistled to the dog, which bounded off to join him.

Somewhat intermediate between independent action and deliberate cooperation are the accounts next to be given, in that the dogs acted in a sense as conscious helpers to their masters.

The first account of this character is from the pen of Pierce Egan,[2] who tells of a Newfoundland dog that on one occasion was observed to fish in the river Clyde. A codfish about eighteen inches long was leaping out of the water and thus came to the attention of the dog, which "at a favorable moment plunged into the Clyde and disappeared for a short time. He then made his appearance with the fish in his mouth and delivered it to one of the servants [of his master] with very few marks of violence upon it."

Sir John Richardson,[3] quoting from a correspondent of his, gives the following interesting note regarding the habits of the sail fluke (one of the flatfishes) and the fate that overtakes it: "It does not take a bait, and he only once saw it caught in a net, but it comes ashore spontaneously, with its tail erected above the water, like a boat

[1]Hudson, W. H. *Far Away and Long Ago: A History of My Early Life*. New York, 1918, p. 101.

[2]Egan, Pierce. *Book of Sports and Mirror of Life*, etc. London, 1832, p. 284.

[3]Richardson, John. "Singular Account of the Sail Fluke." *Zoologist*, 1860, Vol. 18, pp. 6993–94. Also in 2nd Supplement to Yarrell's *British Fishes*, 1849 ed. [citation not verified].

A spaniel that for many years supplied the Pères Cordeliers d'Etampes with crabs and fish is here seen bearing to his masters a characteristic contribution for the larder. So skillful was this dog and so meritorious were his services that a local poet celebrated his exploits in Latin verse

under sail, whence its name. This it generally does in calm weather, and on sandy shores, and the country people near such places [in Scotland] train their dogs to catch it." The fluke, left on the beach by the receding wave, burrows in the sand, from which it is dug out by a dog.

Ernest Menault in his *Intelligence of Animals* (English translation, New York, 1869) quotes from the *Histoire d'Etampes* to the effect that a clever spaniel served the Pères Cordeliers d'Etampes for many years as a purveyor of crabs and fishes. Indeed Menault states that so celebrated was this animal and so many capital dinners had he provided for the friars that in 1714 a local poet celebrated his exploits in Latin verse. The figure with which Menault illustrates his account is reproduced above.

In a book by an anonymous writer,[1] published in 1865, there is an account of a still more remarkable kind of fishing by a dog, namely, that on the sands of the seashore left exposed by the retreating tide. A party of English gentlemen were watching the various methods of fishing carried on at low water at a certain point on the coast of Normandy, when they saw an old woman pass by equipped with a fish-basket and a pickax and accompanied

[1]Campbell, J. T. Editor. *Life in Normandy. Sketches of French Fishing*, etc. Edinburgh, 1865. 3rd. Ed., pp. 124–26.

by a dog. They followed her out on the beach to a spot where the sands, instead of being smooth, were covered everywhere with little mounds.

"Go and seek, good dog Trompette!" said the old lady. . . The dog started off, hunting in all directions. In a quarter of a minute he stopped at one of the little lumps, and began to scratch and whine like a terrier at a rat-hole. "See, he has one," said the woman, as she ran towards the dog, brandishing her pick-axe. When she reached the place, she looked to see which way the hole ran, and then began tearing up the sand, which rose in lumps at every blow. After eight or ten strokes out tumbled a conger eel about the same size as those in her basket.

This she killed and put in her basket and cried, "Seek again, Trompette!" This the dog did and in five minutes they had caught five large conger eels. Inquiry elicited the fact that a young dog was trained by being taken out once or twice with an experienced animal; thus instructed by example, it would soon learn to hunt quite well itself.

The instance last mentioned has prepared the reader for the cases, now to be cited, of dogs serving as aids to fishermen in their business. That man should instruct dogs to this end is after all not so strange. He has trained dogs to hunt for him, to drive birds into a net, to catch and bring to him disabled birds, and to dive and hunt for otters. The first statement of the use of a dog for fishing is from an old book on fishing by James Saunders[1] dating back to 1724. His circumstantial account is as follows:

In Devonshire I have observ'd how they fish with a Dog, a way I have never met with anywhere else, but it is in one particular Case, which is thus, they make Pallisadoes and cross Stakes at the Tail of a Mill, the cross Pieces are set pointing inwards like a Mouse Trap to one another, and the Points so close together, that when the Tide comes up, the Fish slide insensibly between the Points, but cannot find their way out again when the Tide ebbs again; so that they are left in the Dock of the Mill Tail, where the sides being walled or wharft with Stone, and the Mill shut down at the higher End, the cross Rails standing athwart the lower End, and pointing so near to one another as above, the Fish are left within, in about a Foot or Foot and a Half of Water only.

When the Tide is thus out, the Fish which are generally Salmon in the Season, and Salmon Peall when the Salmon Season is over, are all to be seen; then they place a shove Net at the end of a Pole, at the lower end of the Dock or Mill Tail, and turn in a Dog, who is bred to the Trade, at the upper End, and he drives all the Fish into the Net, and so dextrous are they at their business, that if a Fish gets into a little Hole or under a Stone, as if it were unwilling to be driven on to its Ruin, the unlucky Curs will wrack them out with their Feet.

The next account is contained in a letter written by William Hamilton from Portrush, Ireland, in 1784,[2] and records an incident that occurred on a ride from Portrush to the Giant's Causeway. As it is the basis of a number of other accounts, it will be quoted here in full:

We had occasion to ford the river Bush, near the sea; and as the fishermen were going to haul their net, we stopped to see their success. As soon as the [their] dog perceived the men to move, he instantly ran down the river of his own accord and took post in the middle of it on some shallows where he could occasionally run or swim, and in this position he placed himself, with all the eagerness and attention so

[1]Saunders, James. *The Compleat Fisherman, being A large and particular Account of all the several ways of Fishing now practised in Europe.* London, 1724.

[2]Hamilton, Wm. *Letters Concerning the Northern Coast of the County of Antrim . . . together with the Natural History of the Basaltes*, etc. Dublin, 1790. Part I, pp. 111–12. Also in Pinkerton's *Voyages*, 1809, Vol. III, p. 887.

strongly observable in a pointer dog, who *sets* his game; . . . the fish, when they feel the net, always endeavor to make directly out to sea. Accordingly one of the salmon, escaping from the net, rushed down the stream with great velocity, toward the ford, where the dog stood to receive him at an advantage. A very diverting chase now commenced, in which, from the shallowness of the water, we could discern the whole track of the fish, with all its rapid turnings and windings. After a smart pursuit the dog found himself left considerably behind, in consequence of the water deepening, by which he had been reduced to the necessity of swimming. But instead of following the desperate game any longer, he readily gave it over, and ran with all his speed directly down the [bank of the] river, till he was sure of being again to seaward of the salmon, where he took post as before in his pointer's attitude. Here the fish a second time met him, and a fresh pursuit ensued, in which, after various attempts the salmon at last made its way out to the sea notwithstanding all the ingenious and vigorous exertions of its pursuer.

In this instance the dog seemed to have had two objects in view; either to catch the fish or to drive it back into the net. And though he failed on this occasion, the fishermen reported that it was not unusual for him to run down and catch the fish, and that he was of the greatest assistance in turning the fish back into the net.

This account is reproduced with slight changes in Edward Jesse's *Gleanings in Natural History*, London, 1838, pp. 70–1; in Yarrell's *British Fishes*, London, 1836, Vol. II, p. 24; and in Frank T. Buckland's *Familiar History of British Fishes*, London, 1873, pp. 132–33.

Yarrell[1] also writes that a correspondent of his assured him that in Glamorganshire dogs were used in the manner above indicated to drive salmon into the net. And another correspondent wrote him that he knew a poacher in Devonshire who after setting a trammel net at the lower end of a pool in the river, would send his dog (which he had trained to dive like an otter) in at the upper end to drive the fish into the net. The like use of a dog in south Wales is vouched for by a writer signing himself A. Guest.[2] The details need not be given as the procedure was essentially like that recorded in the accounts given above.

In closing, incidents of this use of dogs are cited from the narratives of travelers among a very degraded and primitive race of people in a far-off part of the world, namely in the Straits of Magellan. In 1768, John Byron[3] and the ship's company of the "Wager" suffered shipwreck on the coast of Patagonia. After enduring fearful hardships from cold, hunger, and lack of clothing (which eventually killed off all but a mere handful of the men), the survivors were forced to call on the wretched inhabitants of the country to aid them in fishing—the sea being practically their only source of food. Then they found that the natives made use of their dogs to drive the fish into the corner of an inlet or bay, where they were easily caught. Byron's fullest statement is as follows:

. . . and [they] then went out upon another kind of fishery by the means of dogs and nets. These dogs are a cur-like looking animal; but very sagacious, and easily trained to this business. Though in appearance an uncomfortable sort of sport; yet they engage in

[1]Yarrell, Wm. A. *A History of British Fishes*, 2nd Ed., 1841, p. 59.

[2]*Angler's Notebook and Naturalist's Record*, Series I, London, 1880, p. 10.

[3]Byron, John. *The Narrative of the Honorable John Byron Containing an account of the great distresses suffered by himself and his companions on the coast of Patagonia . . . also a Relation of the Wager Man of War.* 2nd Ed., London, 1768, pp. 56, 127, and 134

it readily, seem to enjoy it much, and express their eagerness by barking every time they raise their heads above the water to breathe. The net is held by two Indians, who get into the water; then the dogs, taking a large compass, dive after the fish, and drive them into the net; but it is only in particular places that the fish are taken in this manner.

Captain Fitzroy[1] had read Byron's narrative and when surveying in the Straits of Magellan about 1836, he was on the lookout for this interesting phenomenon. However, he did not see the Fuegians carrying on such a method of fishing, nor could he obtain hearsay evidence for the existence of such a practice. Nevertheless he gives full credence to Byron's account, for he observed native dogs on otter hunts swim, dive, and pursue their prey most eagerly.

Darwin, who visited the region in the "Beagle," makes no reference whatever to this method of fishing in his *Voyage of the Beagle*. But there is one other writer who substantiates the statements of Byron. Marin[2] says that in the lateral channels opening out of the Straits of Magellan, the Fuegians use dogs to aid them in fishing and particularly in hunting for the otter. It must be confessed, however, that the account has to do mainly with the pursuit of the latter, the dogs, according to Marin, diving after the otters and following them under rocks and amid the recesses of marine vegetation.

It has never been my good fortune to witness such interesting incidents as those here chronicled and hence this article lacks the personal touch. However, since I began gathering material for it, there has come to my knowledge a series of experiences which I am fortunate in being able to set forth in conclusion. These were related to me by Mr. Guy V. Ferguson, now a resident of New York City, but in his boyhood days a fellow countryman of mine in western North Carolina. I have known Mr. Ferguson long and well, and I also know the locality wherein the incidents related took place. Full credence can be given to this recital.

The largest stream in my native county of Haywood is Pigeon River, so named because of the great prevalence on its banks in former days of the passenger pigeon. About ten miles north of my home town, Waynesville, the river receives a tributary from the east, Crabtree Creek, and about one mile from this point of junction Crabtree Creek in its turn receives an affluent, Rush Fork, formed of brooks rising on the flanks of Crabtree Bald, a mountain about 6000 feet high. One half mile up Rush Fork, Mr. Ferguson was born and spent his boyhood days, and there the incidents related took place.

Both the river and the larger creek, flowing through miles of farming country, are, and were even at that day, somewhat turbid, while the shorter Rush Fork is clear and sparkling. Into this small stream every spring there come to spawn fishes of the "sucker" tribe, hog-suckers, white-suckers, and red-horse. Now in that day and time our country was full of game and our streams were full of fish, and hence every farmer's boy had a dog, generally a good hunter, and in the case of Mr. Ferguson's dog "Fred," a good fisherman as well.

In the spring, when the fish began to run up in the small creek,

[1]Fitzroy, Capt. Robert. *Narrative of the Surveying Voyages of H.M.S. "Adventure" and "Beagle" . . . 1826–36* [on] . . . *the Southern Shores of South America*. Vol. II, "Proceedings of the Second Expedition," 1831–36, p. 187.

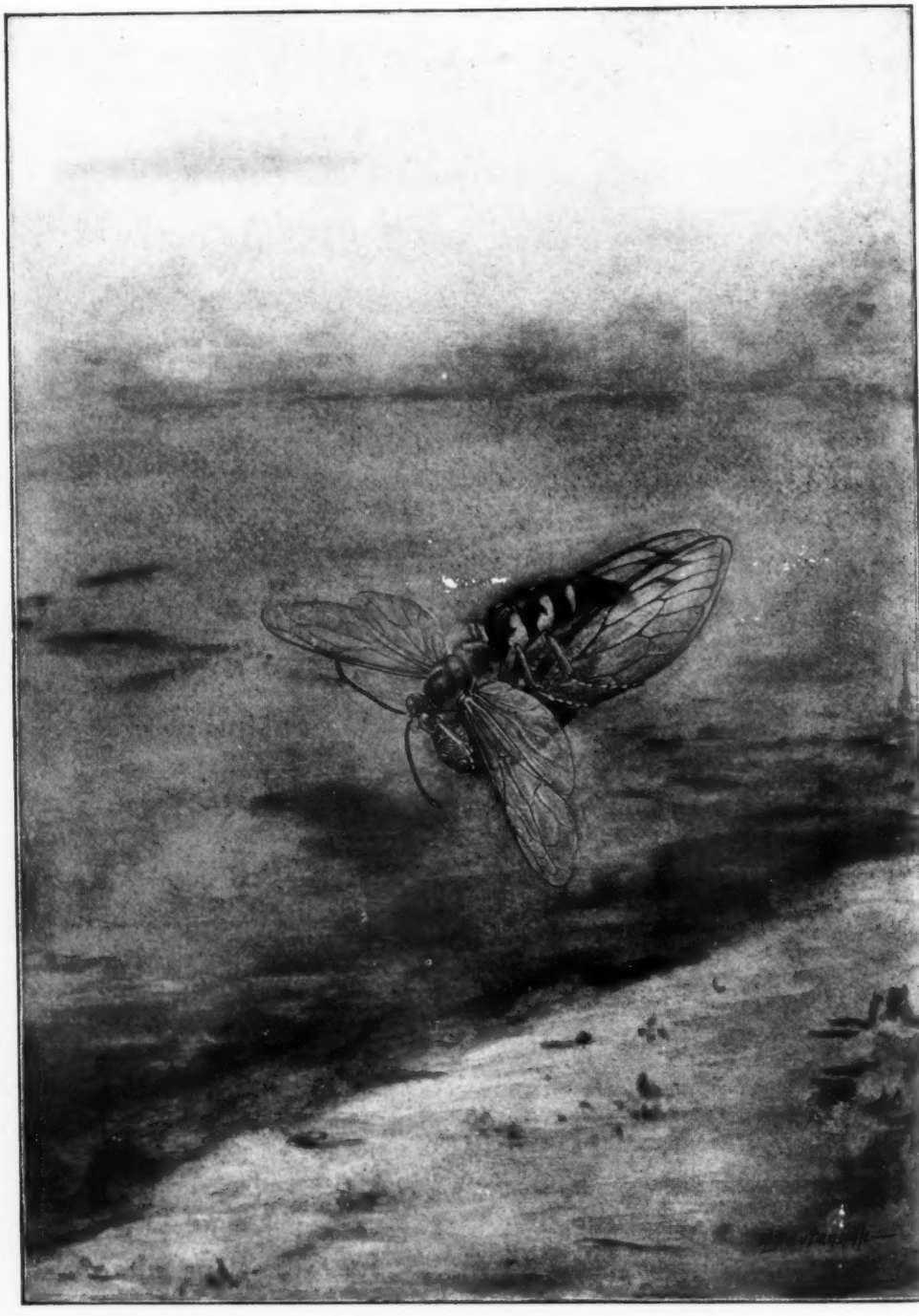
[2]Marin, Aylic. *Au Loin. Souvenirs de l'Amérique du Sud et des Isles Marquesas*. Paris and Lyons, 1891, p. 117.

Ferguson and his brother would sally forth with "gigs," or three-pronged Neptune's tridents, to strike these fish, and with them almost always went the dog. Frequently they went at night carrying torches, for then the fishes were more easily caught. In case a stricken fish succeeded in tearing himself from the gig and made an attempt to get away, or in case one scared by the approach of the boys and dog darted ahead on the shoals, the dog would leap forward and often catch it. Presently he became very expert, and in time began to fish for himself.

The chief sphere of operations of the two boys was in the fertile "bottom" (alluvial) land lying immediately along the creek. Here, day after day, when the boys went to work, the dog would come also, to chase ground squirrels and dig out moles, and eventually to fish for himself in the near-by stream. In the creek, the water on the riffles was only a few inches deep and in the pools rarely more than a foot and a half in depth, and here the dog had great sport. Not infrequently his master would hear a considerable commotion in the stream, joyous barkings and loud splashings, and on running to the spot would find the dog chasing the fishes or perhaps coming out with one in his mouth. His biggest catch was a carp about eighteen inches long which had been carried in some flood from a pond into the river and had at a later time, probably during a heavy rain, made its way up into this small creek; subsequently, the falling waters had left it behind in a pool. It was just about all the dog could do to handle it.

Here, as in so many of the cases cited, the dog was fishing for pure sport—the quadruped striving for the same end as his biped master and accomplishing it in his own way.

Watchful waiting, with aggressive intent.—This picture is reproduced from Richard Jefferies' volume, *The Gamekeeper at Home* (1880). The pointer found diversion in removing the fishes from the tub and in repeating the performance when they were put back in the water (see pp. 562-63)



A NESTWARD FLIGHT

A cicada killer on the wing bearing her inert prey to the burrow she has dug in the soil flanking the pathway. From a painting by Mrs. Edna L. Beutenmüller

A Wasp That Hunts Cicadas

By WILLIAM M. SAVIN
Illustrations from photographs by the author

DURING the early days of August, 1922, in a meadow near my summer home in New Jersey, the cicada killers, *Sphecius speciosus*, had made a settlement, consisting of more than two score independent nests. With few exceptions these burrows were placed within an area of six hundred square feet. Close by ran a brook and along its banks within fifty feet of the nests grew several trees from which the wasps were accustomed to fly with their captives held clasped against the underside of the body. Conditions were, therefore, most favorable for the study of these wasps.

The female of *Sphecius speciosus* devotes herself to the capture of cicadas, which she stings and paralyzes and subsequently carries to her nest to serve as food for the larva that will hatch from the egg that she lays on this prey. Many cicadas doubtless fall victims to these persistent huntresses. One day within twenty minutes the wasps were seen bearing eight cicadas to their several burrows in the settlement.[1]

In the ground (preferably clayey soil) the wasp mother excavates a tunnel having a diameter of about an inch. This slopes gently downward for six inches and then usually makes a turn at right angles. In the long tunnels a number of such turns occur. There is a great variation in their length: some run only a foot, others four feet. The majority of those in this settlement extended for about two feet. Frequently a number of branches are projected more or less forward from a central point in the tunnel, each branch terminating in a round cell about one and three-fourths inches in diameter. The termini observed were always slightly nearer the surface of the ground than were the tunnels. This afforded better drainage and in many instances must have prevented the stored food from becoming moldy through an accumulation of water in the cells.

When excavating the tunnel the wasp walks out backwards, dragging the dirt and placing it loosely in front of the entrance. Sometimes the pile of dirt is about a foot in diameter. As the wasp trails through this dump heap, she leaves a groove, the presence of which is indication that work on the nest or in connection with its provisioning is still under way. For several days, while these nests were under observation, it showered and the grooves were effaced, making it impossible to determine offhand whether the tunnels had been completed and the cells stocked.

Each cell is stocked with one or two cicadas, only one egg, however, being laid per cell. Among the cells uncovered in these burrows the greater number contained two cicadas. The female of *Sphecius speciosus* is larger than the male and it has been suggested that the supply of two cicadas is left as food for the larva that will metamorphose into a female wasp, the single cicada being sufficient food for the larva that will emerge as a male wasp.

On one occasion I found in a cell three cicadas that were somewhat

[1] As Mr. William T. Davis has pointed out (*Bulletin of the Brooklyn Entomological Society*, Vol. XV, No. 5, December, 1920) *Sphecius speciosus* is an indiscriminate collector of cicadas and will often place more than one species in the same burrow.

HUNTRESS AND VICTIM

The wasp does not confine her captures to a single species of cicada nor does she apparently take more males than females even though the noisy singing of the male might seem to give him a prior claim, however unenviable, upon her attention

smaller than usual. Possibly the mother was absent-minded in providing the extra one, or again the fact that the prey was undersized may have influenced her to make up through number what the individual captures lacked in bulk.

The egg hatches in two or three days and the emerging larva disposes of the edible part of the cicada within a week or more. It then spins a cocoon about itself, requiring two days to finish the work. The cocoon is made of silk mixed with dirt, which is evenly distributed; it is dark brownish in color and crusty. The larva rests within the cocoon until the following spring when it undergoes pupation, emerging as an adult wasp before the appearance of the cicadas in midsummer.

Stocking the nests with cicadas is no easy task. As the weight of the victim is about twice that of its captor, the burdened wasp is unable to make extended flights on the level; consequently she flies obliquely from a tree to the burrow. In many instances the wasp is obliged to drag a cicada up a tree to a point of vantage before undertaking her downward flight to the nest.

The captive cicadas were for the most part borne from a linden tree, *Tilia americana*, about fifty feet distant across the brook. Some of the wasps before hunting engaged in what were evidently practice flights between the tree and their respective burrows. Occasionally they would visit the nest site without a captive cicada, remaining outside of the tunnel. In such cases the wasp would fly about the entrance in increasingly larger circles, the outer one having a diameter of about thirty feet. This probably gave the insect some impression of the surroundings of the burrow to assist her in her return flight.

Again, starting at a burrow, a wasp would fly five or six feet in a direct line toward the linden tree. Returning to the burrow she increased the next flight by five or six feet. A number of such flights were made until she went from the burrow to the tree in one flight. Each flight was at an angle of about forty-five degrees.

In bearing a victim from the tree to the burrow a wasp would often alight at the entrance and at once drag the cicada into the tunnel. At other times the insect would land a foot, or more, from the burrow among the grasses. The obstacles in her path caused her to flounder about considerably and it was with great difficulty that she reached the nest. On one of these occasions the wasp came across a ragweed, *Ambrosia*, about eighteen inches in height. She dragged the cicada, ventral side uppermost, to the top of it and flew to the burrow two feet distant. Dragging the victim along the ground is evidently burdensome and the cicada hunter apparently embraces the slightest opportunity to fly to her burrow from an elevation.

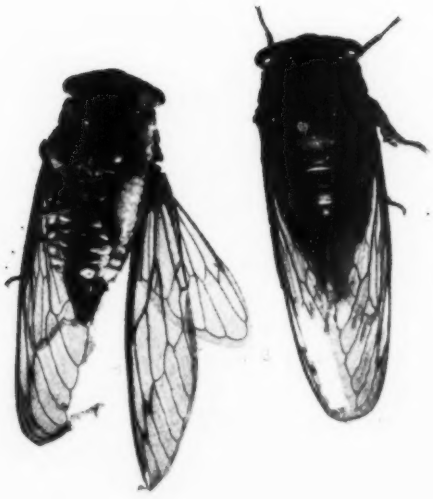
On two occasions when we dug into the burrows, the proprietress was discovered within. One of the two wasps thus surprised was engaged in making her tunnel, twelve inches of which she had completed. When she was uncovered, she flew out but not at us. Although our destruction of the burrow had left an excavation a foot square, thereby changing the appearance of the surroundings, the wasp returned to her well-nigh demolished tunnel and resumed her work, extending for another foot the passageway with its several branches, the terminal cells of which she stocked with cicadas. The other wasp had completed a four-foot tunnel and was apparently de-

positing a cicada in the end cell when we came upon her in the course of our excavation of the burrow. I judge by the noise she made that she was greatly annoyed; she flew away and did not come back to the nest. On our return to the site we found in the excavation a cicada which the wasp had probably taken from the cell and dropped there. No egg was laid on it.

On two occasions we tried to secure a wasp as she alighted near her burrow with a cicada by placing a jar above her and gently lowering it. In each instance, when the jar was within about an inch of the wasp, she abandoned the cicada and flew away but not toward us. A wasp with her prey was then easily secured with a net.

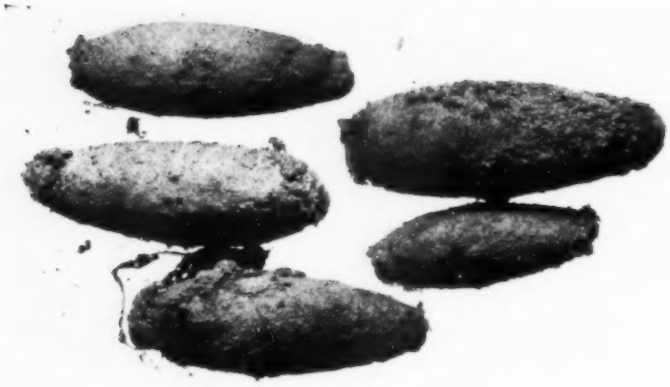
At times these wasps, it would

The dark hole shown in the picture is the entrance to the burrow of the cicada killer. When excavating the tunnel the wasp drags the dirt out into the open, walking backward. The layer thus formed is sometimes nearly a foot in diameter

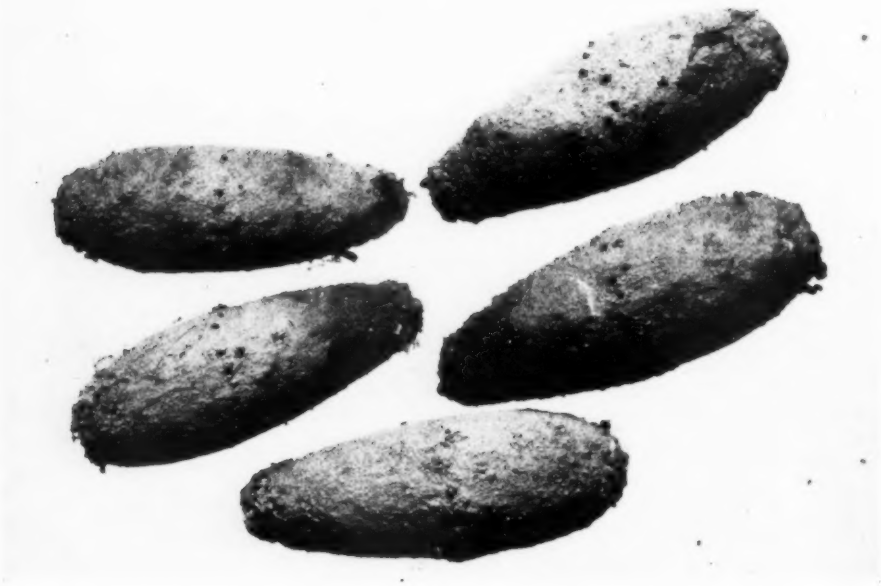


Frequently the huntress stocks a cell of her burrow with two cicadas for the voracious larva that is to be the beneficiary of her prowess. In the above picture the hatched larva may be seen on the side of the cicada to the left

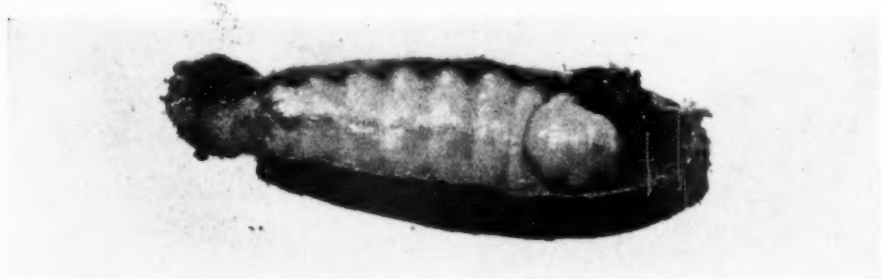
After the larva has reached a certain stage of development thanks to the nourishment obtained through the circular openings it has made on the ventral side of the two cicadas, it foresakes the remnants of the feast and spins a cocoon



The five smaller cocoons (left) were derived from cells in each of which the wasp mother had left only a single cicada. The five large cocoons (below) were taken from a like number of cells each of which had been stocked with two cicadas



When spinning the cocoon, the larva mixes quantities of earth with the silk, giving it the appearance of having been made of mud. A dozen or more pores occur close together on one side of the cocoon, and it has been suggested that their function is to aid in the respiration of the larva



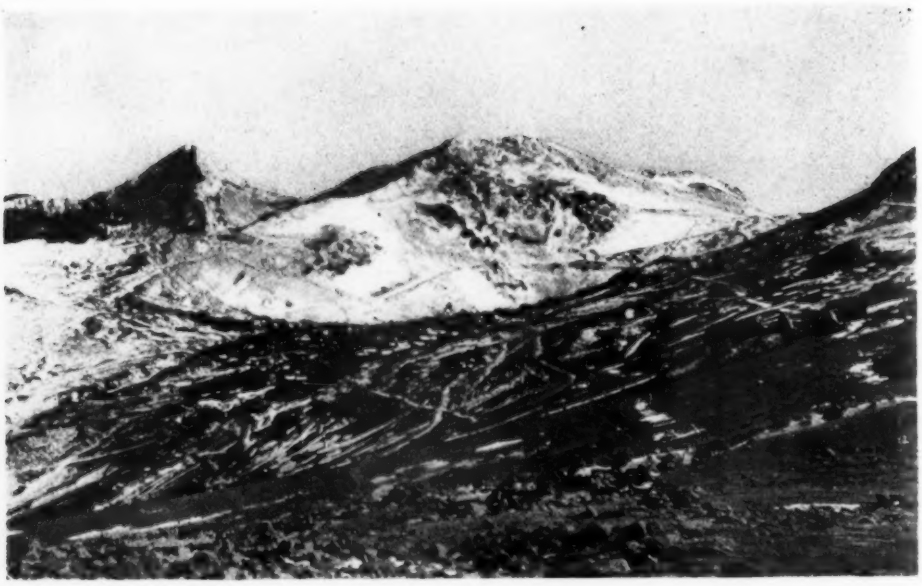
A cocoon of the cicada killer which has been opened to show the larva resting within —its head in the large end. The larva remains in the cocoon until the following spring when it undergoes pupation and later emerges as an adult wasp

seem, keep watch over their burrows from a distance. Once at nightfall, thinking the wasps would not be about and that it would be a favorable time to dig into the burrows, we visited the nests. When we reached the settlement, no wasps were in evidence, nor was the sound of a cicada heard. After working for about five minutes, however, a number of wasps appeared and flew about us as well as the burrows with more show of excitement than when we had worked among them in the daytime.

The cicada killer, *Sphecius speciosus*, does not seem to live up to her reputation for ferocity. During these observations, covering several days, not once did the wasps administer a sting. Like other solitary wasps they seem to prefer to conserve their poisonous fluid for injection into their captives.

Not always does all run smoothly for the larvæ of the cicada killer. Sometimes the burrows become excessively damp and the cicadas placed there turn moldy. They are thus rendered unfit as food and the larvæ, deprived of their sustenance, die.

At times a fatality seems to befall also the adult wasp when in the burrow, and she too may then become moldy, as indicated in the case of the wasp on the left of the picture



Colquechaca's highest peak with an abandoned mining town at its base

The Treasure House of Spain

THE FAMOUS NEW-WORLD MINES OF ORURO, COLQUECHACA, AND POTOSÍ

By EDWARD W. BERRY
Professor of Palæontology, Johns Hopkins University

HISTORY and fiction both abound with references to King Solomon's Mines, although these were really insignificant compared with those of the Emperor Charles the Fifth, or of his son King Philip, which were wrung from the Incas by a handful of war-hardened adventurers, whose achievements, even when shorn of romance and the exaggerations of the early chroniclers, still seem more like fiction than sober history.

Imagine the little band of fortune-seekers led by the swineherd of Estremadura, Francisco Pizarro, sweltering through the humid morasses from Nombre de Dios to Old Panama, and then transported to the wind-swept Andean heights with their thin air, and the record of their achievements is sufficiently remarkable to offset many of their crimes. Grant the abjectness and lack of spirit of the Indian population—the natives are unassertive today and must have been so in the past. Nature was seemingly a more relentless foe than the Indians, and the difficulty in overcoming it was scarcely realized in Prescott's day, nor can the obstacles encountered be fully appreciated by any one who has not traversed the old trails. Thanks to the Inca custom of establishing supply houses along the routes, the danger from famine was reasonably remote, but the passes are inconceivably high to those accustomed to the passes of the Alps or Rockies. That which we traversed in going from Huancavelica to Santa Inéz was 16,500 feet, or higher than any peak in the United States. The cold is intense, fuel is wanting, and the

effect of the rarified air is sometimes remarkable. I have seen horses drop dead because of it, and when you consider the armor-laden cavaliers and the burdens that their lowland-bred horses were obliged to carry, it is strange that any of the animals survived.

There was still another adverse factor. Hardy though the Conquistadores were, they were prone to excessive dissipation whenever this was possible, and men so constituted are, according to my experience, the first to feel the effects of altitude. In a trip I made over the Oroya Railroad in 1919 it was not the party of Americans on the train who were affected with "soroche" or mountain sickness, but the natives who presumably, as is their custom, had spent their last night in the City of Kings (Lima) in overindulgence.

Pizarro's band found much gold in Peru, but this huge amount, wrung as a ransom from the unfortunate Atahualpa, had been accumulated by the Incas through several centuries of washing the gravels of the Andean streams, particularly those of the eastern range, and this was no gauge of the amount to be quickly won by mining operations, as the Spaniards soon found to their sorrow. Their search for gold was disappointing, for although it is present in streams all along the Andean front, and in scattered places elsewhere, modern operations have not proved commercially successful to any considerable extent, largely because of the low grade of the placers as compared to the excessive cost of production in such inaccessible regions. In the Montaña jungles it is not an uncommon thing to come across mining machinery of all kinds, rusting and overgrown, that was brought by hand over the heart-breaking upland trails, only to be abandoned when funds and health gave out.

What the Empire of the Incas lacked in gold resources, however, it amply made up in silver. This metal is abundant in what is now Peru and Bolivia, and in the eastern and the western Cordillera. The bonanza silver region of Colonial South America was located in what was known as Charcas, or Upper Peru, now the Republic of Bolivia. Three localities furnished the bulk of the silver that poured thence into Spain's coffers, and offered rich pickings for Drake and other buccaneer admirals of Queen Elizabeth, as well as for the host of pirates that subsequently infested the Spanish Main, of whom Morgan was perhaps the most notorious.

These three localities of Upper Peru were Oruro, Colquechaca, and Potosí, and of these the last far outranks any other in the whole world. Oruro, which was the youngest and least important of the three, is situated on the high plateau of Bolivia, or Altaplanicie, as it is called, which here is only 12,250 feet above sea level, but in a region too arid for agriculture. The town itself is now a most ordinary place, consisting mostly of one-story adobe houses, but it is a considerable railroad center and a place of much business. It is 115 miles southeast of La Paz, the present metropolis of Bolivia, and the old trail from Lima to Buenos Aires is here marked every kilometer by huge adobe monoliths. Considerable mining of silver, tin, and copper is carried on in the surrounding hills, but the scarcity of water makes it necessary to do the milling at Machacamarca some miles to the southward near Lake Poöpo. Oruro now has only about one third the population that it had in the Colonial Period and derives its chief importance from

A native woman and her donkey plodding over the mountains. Much of upland Bolivia is of this arid character

the fact that it is a trade center and shipping point for the hinterland, the prospective mineral and agricultural wealth of which is incalculable.

World-famous Potosí is about midway on the old trade route between Lima and Buenos Aires. Since 1912 it has been possible to reach it by train from Rio Mulato, a station on the Antofagasta-La Paz line 108 miles distant. The single train makes one round trip a week,[1] reaching Potosí Saturday night and returning the following Tuesday. At Condor the roadbed reaches the marvelous height of 15,814 feet, but the route is high without being otherwise notable, and the climate is so arid that glaciers are wanting, and the high mountains with their subdued slopes suggest an overgrown hill country, largely without crags or scenic effects. Were it not for shortness of breath or other unpleasant reminders of the altitude, the traveler would not realize that it is the gable of South America.

[1]During the last year or two the train has been making four trips a week.

On our 1919 trip, however, we chose to go the way that Gonzalo Pizarro, the first proprietor of Potosí, went, and were eleven days on the trail in making the 162 miles from the town of Uncia by mule, although, to be sure, we were not in the saddle all of that time. Uncia, which is at the present time the largest tin-producing camp in South America, is situated east of the divide of the eastern Andes, and about forty-five miles from Machacamarca on the railroad. A mountain of igneous material intruded through the Devonian shales carries rich tin veins, and the two companies that work them from the two sides of the mountain have an annual production valued at nearly $50,000,000. Uncia in August has the wind and dust of a typical March day in the United States, not enhanced to the imagination by the thought of the innumerable germs.

Because of the cold nights one does not rise in the Andes until the sun strikes one's lodging, except under the necessity of an early start for a long-day's mule ride. Consequently one

does not see many sunrises, or that most curious effect assumed by mountains in the diffused light of early dawn, when they seem to be cut out of cardboard and unreal as in a play. One is prone to think of the earth's surface as parceled out into regular zones of vegetation and animal life from the equator to the poles, as they are in the geographies, and it is difficult to become accustomed to following an upland trail in a vegetationless Arctic cold, withal under a tropical sun, reach a great gash in the earth's crust, and switchback down three thousand or four thousand feet into a hot valley, where, if there is water, there is a rich and varied vegetation, with humming birds, flocks of parrakeets, and everything normal to the Equatorial Zone. Such a place was the dirty Indian tambo of Morocacha, where we lunched the first day. The tambo is the official wayside inn for man and beast, but mostly for beast, and is a survival of the rest houses of the Incas. Nightfall brought us to Pocoata, another tiny Indian town, nestled in an out-of-the-way valley. We had covered forty-eight miles in one day—our South American record. A letter to the corregidor or prefect's representative in Pocoata, spared us the tambo and secured for us a bed on the dining-room floor of the corregidor's residence. A short day's ride brought us to Colquechaca, the second treasure house of Colonial days.

Situated at the head of a southwardly-facing valley, amid a group of peaks all of which rise to heights of more than 16,000 feet, the town is small and mean. A thousand feet higher than Potosí, it never attained the wealth, size, or importance of that place. It straggles along a narrow valley; consequently the only approximately level streets are those paralleling the stream, and these are connected by alleys of steps six or eight feet wide, for there are no wheeled vehicles in these Andean towns, and mules find steps of human construction easier of traverse than many of the mountain trails.

The plaza at Maragua, one of the remote little Indian valley towns

The main street of Colquechaca backed by its symmetrical peak.—Three hundred years ago Colquechaca was well known for its rich silver mines. Mementos of its former days of prosperity are the roofless stone walls of many an old house, three fourths of the town being composed of habitations that are today deserted. In several of the principal streets these old houses are being re-thatched and whitewashed, and in years that are perhaps not far distant the community may again rise to prominence as a mining center

Tin washing in the Tarapaya Valley below Potosí.—The Spaniards valued only the precious metals, and in their time tin was neglected. But today the tables are turned, and tin is claiming the attention of the miner in the very region where silver was formerly the chief attraction

Three hundred years ago Colquechaca was a thriving town, noted for its rich silver mines and with a large population. The roofless stone walls of the former habitations still comprise three-fourths of the town, and there are two more ancient and smaller towns now entirely abandoned, higher up among the peaks. Colquechaca was noted for the richness of its ores—pockets and shoots of ruby silver occurring plentifully at irregular intervals in the otherwise rather lean veins.

The mountain mass around Colquechaca forms an area of igneous rocks about eight or ten miles in diameter, which was intruded through the sedimentary red sandstones and shales, and it is a part of the same series of intrusions that follow the eastern Andes all across Bolivia from north to south and that are the source of the silver and tin minerals for which that country is famous. The colonists mined only the silver, but recently a considerable amount of tin concentrates has been produced. The district probably has a great future but its immediate past has been one of decay. The San Bartolome tunnel, which starts at the upper end of the town and penetrates for a mile into the mountain mass, struck a vein with phenomenal silver riches, one which was once worked over a vertical range of about two thousand feet. With the decline in the price of silver toward the close of the last century this, the largest of Colquechaca's mines, was allowed to fill with water, and all of the workings, extending for several hundred feet below the tunnel, have been flooded for more than a generation.

Evidence of former greatness is seen in an immense pump room with its old Cornish pump, and the roomy chapels and shrines, all hollowed out of the solid rock. Along several of the main streets of Colquechaca the houses have been re-thatched and whitewashed, and the town is becoming reanimated. It is one of the highest mining towns in the world, cold and inhospitable, prone to snow squalls and electrical storms. Autos can now reach it over the valley trail from Challapata on the railroad about eighty miles away, and Sucre, the old capital of the republic, is only about sixty miles by trail to the southeast. Potosí lies about one hundred miles to the southward of Colquechaca, and to reach it requires four days on the trail, stopping at unheard-of Indian towns nestled in far-away deep valleys, as out of the world as if they were on another planet.

To me Potosí will always remain the most interesting town in South America—historically, architecturally, and scientifically. For years I had looked forward to visiting it, and the symmetrical cone of its silver mountain, visible from the divides two days' journey away, stimulated the imagination of the present-day traveler much as it must have done that of the greedy Spaniards of old, whose ghosts, in our imagination, constantly haunted the trails. One seemed to live again with Gonzalo Pizarro and amid the countless dramas of the past. There is no spot in South America that offers more material for the novelist than this city of romance and the trails leading out to the coast and northward across the mountains to Sucre, and I can only hope that some future Ibañez will rise up and make them forever famous.

The trail to Potosí makes its final plunge down from the upland into the Tarapaya Valley twenty-eight kilometers below Potosí, and from here onward the road is good, leading as it

does to Miraflores, where there are famous hot baths—relics of some former igneous intrusion. In a land where hot water is too scarce ever to be wasted in washing, hot springs are a boon. Someone has said that the traveler in South America will feel so much cleaner than the natives that baths will seem unnecessary. This is, of course, a libel, but it is not surprising that with frost every night and no fuel except *taquia*, the droppings of the llama, and *yareta*, a resinous mosslike plant (*Azorella*) any attempt at cleanliness might easily prove fatal, and extreme aridity makes it possible not to take too many risks of this sort.

Prescott writes picturesquely of Inca aqueducts and baths, but so far as my experience throughout the limits of their former empire indicates, the Incas never bathed—at least their descendants never do, and the aqueducts of fiction are mainly irrigation ditches, the building of which is the one art in which the mountain Indians really excel, and the "baths" are invariably storage reservoirs.

The broad trail winds up the Tarapaya Valley between 40° dip slopes of red sandstone. At San Bartolome the trail turns to the eastward through a picturesque gorge, which the Rio Potosí has cut through the red beds, and swings up past San Antonio and Cantumarca—the latter an Inca town—to historic Potosí near the head of its valley, backed by the Kari Kari Mountains and flanked on the right by its historic Cerro, or mountain.

Potosí is hilly, although not so much so as La Paz; nevertheless it is regularly laid out. Its plazas are notable despite the fact that the climate precludes trees. Its architecture is especially picturesque even though many of the ancient dwellings, churches and other public buildings have been allowed to fall to pieces. All of the better houses are at least two stories in height, and mostly of adobe, which, however, has been supplemented with much stone. Varying combinations of tower, hanging balcony, ornamental cornices, barred windows, and Moorish metal work and stone carving, with the variously gabled and invariably tiled roofs, give an artistic quality and an individual character to each building, reminiscent of Grenada or Seville, and this similarity is rather enhanced by the pronounced sag of the more ancient rooftrees under their weight of red tiles. The Court of Lions at the Alhambra cannot compare with the Cerro-backed plaza shown in the illustration on page 584.

Sufficient water for industrial purposes has always been a problem here as elsewhere in Peru and Bolivia, and at the height of the city's prosperity twenty-seven artificial reservoirs, some of them of immense size, were constructed among the moraines that stretch like fingers down from the Kari Kari Mountains east of the city, to impound the summer rains. There are also thirty-two aqueducts of ancient date, many of which are now in a state of dilapidation.

About the year 1460 the Inca, Huayna Capac, paid his first visit to this region, and in journeying from Cantumarca to Porco—the latter a near-by region which was worked by the Indians for its silver several centuries before the coming of the Spaniard, as is attested by the pre-Spanish slag dumps—got his first view of Potosí, which the Quichua Indians called "Sumac-orcko," or Beautiful Mountain. The Inca, so runs the legend, was impressed with the idea that a mountain of such grandeur must

surely contain precious metal, and accordingly ordered that it be mined. In obedience to the emperor god the Indian miners made preparations to tunnel into its flanks but were warned away by the Achachila, or spirit of the mountain, and since that time it has been called Potosí, or mountain of great noises—doubtless in allusion to the terrific electrical storms that play around its peak in summer.

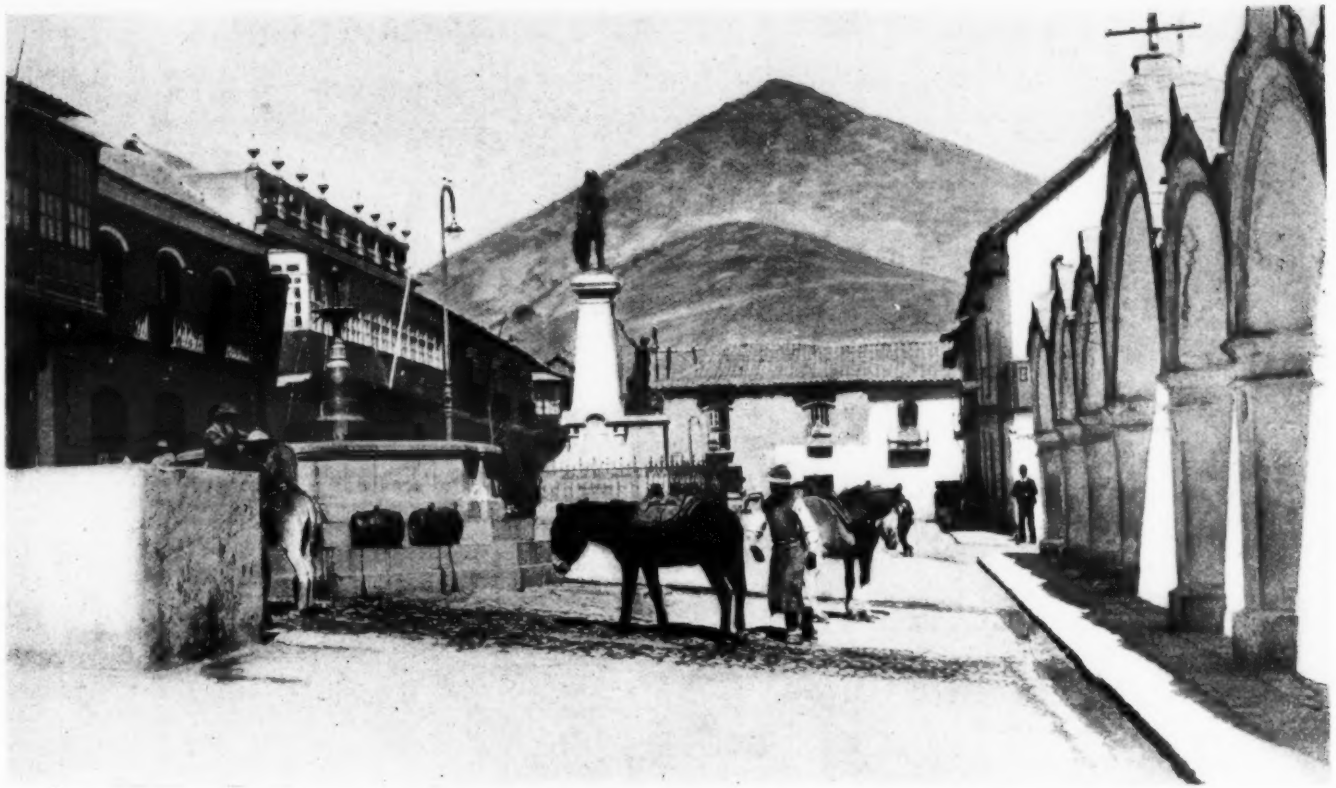
Tradition states that the Spanish discovery of silver at Potosí was accidental. An Indian from Porco, searching for a stray llama and camping on the mountain for the night, found the smelted ore in the remains of his camp fire the next morning. Similar apocryphal stories are told of all great mines and inasmuch as there is not a trace of anything on Potosí Mountain that would furnish fuel for even a modest camp fire, we may well discredit the legend. At any rate, the discovery of silver at Potosí was undoubtedly due to its proximity to the Porco silver mines, and active mining at Potosí commenced in 1545. The surficial ores, which were naturally the first to be mined, were found to be phenominally rich, the friar, José de Acosta, estimating that the production from 1545 to 1572 amounted to $250,000,000.

The mineralization is really remarkable—it is said that any hand specimen of the 15,000-foot cone will assay at least a trace of silver, and the actual ores from the innumerable veins contain small amounts of gold and copper along with the larger amounts of silver and tin. Strangely enough the adjacent peaks consisting of the same rock totally lack the metallic ores. The Spaniards were interested in precious metals solely, consequently tin and copper were produced only in sufficient quantities for the amalgams used in making utensils and the innumerable church bells, which no hamlet in the Andes, however remote, lacks. It is only in recent years that iron from the outside world—for there is none here—has replaced bronze in the native mining industries.

Most of the silver, some say all of it, was recovered by the amalgamation process, the mercury for which came from the scarcely less famous quicksilver mines of Huancavelica in the Peruvian Andes nearly one thousand miles away. The tin which is associated with the silver was allowed to go down stream in the tailings and the 375 years' accumulation of these has formed rich alluvial tin deposits wherever the channels of the Rio Potosí or Rio Tarapaya widened out and formed playa deposits.

In these effete modern days of industrial civilization tin is a greater desideratum than silver—consequently Potosí is now more of a tin than a silver camp. Some idea of the value of the tin can be gathered from the fact that it is found profitable to wash over the old mine dumps high up on the mountain in the rude *quimballales*, or jigs, with water brought up from town in five-gallon gasoline cans by mules or burros.

A crown tax on the silver produced was imposed in 1556 and this brought great sums into the monarch's war chest, and helped to pay for the Spanish Armada and the wars in the Low Countries. With the working out of the rich oxidized surface ores there was a falling off in revenue and the viceroy, Toledo, was sent out from Spain in an endeavor to improve the situation. Indians were enslaved from as remote regions as Ecuador and many thousands, particularly those from the low-lying countries, quickly worked



THE CONICAL CERRO FROM THE EAST END OF THE MAIN PLAZA OF POTOSÍ

Active mining at Potosí began in 1545. It has been estimated that, in the course of the twenty-seven years succeeding, metal worth $250,000,000 was obtained from its ores. Originally famed for its production of silver, Potosí today is predominantly concerned with the mining of tin

Courtesy of the Pan American Union

ONE END OF POTOSÍ'S MAIN PLAZA

their lives away in the company of countless llamas. Chroniclers, prone to exaggerate, give the number of Indians that were worked to death in the mountain as 8,250,000.

In 1739 the crown tax was reduced from 20 to 10 per cent. This is clear evidence, not of the beneficence of the monarch but of the increasing difficulty from water and the mounting costs of working at depths. These depths had in some cases reached 1700 feet below the surface and there were no other means of taking out either the ore or the water except on the backs of Indians. Gradually the lower levels became flooded, the protracted struggle for independence, which commenced in 1809 with resulting interruption of mining hastening the process, so that in the nineteenth century production was much less than in the sixteenth century.

Many and conflicting estimates of the amount of silver obtained at Potosí during Colonial times are extant. On the basis of the royal tax collected, which amounted to $575,780,000 between 1545 and 1809, as shown in various audits of the royal treasury, the production has been figured at $5,594,000,000, an average of more than $21,000,000 per year for 264 years. Even allowing for exaggeration, and dividing this huge sum by two or three, the result is still the enormous total of $2,000,000,000 or $3,000,000,000 for the entire period, and this does not take into account the very large amount exempt from taxation that went into church service—the massive silver candlesticks and altars still to be seen in the cathedral at Sucre testify to the use of the metal in this manner. Among these are four of an original set of twelve, each of which is more than six feet tall and so heavy that it cannot be tilted by one man unaided; and in its prime there were sixty churches in Potosí alone. Neither do these estimates take into account the amount which evaded the tax through being smuggled out of the country. There was a regular trade in contraband silver and the amount was sufficient to give the name of La Plata, or Silver River, to the estuary of the Parana and Uruguay on the east coast of South America, and all of this came from Bolivia, and most of it from Potosí.

Forty-eight years after its foundation, that is in 1595, or twenty-five years before the Pilgrims landed at Plymouth, it is said that Potosí had 160,000 inhabitants. This is doubtless an exaggeration—the ruins of today do not indicate more than half of this number in the town itself. It is quite within the range of probability, however, that at the height of its prosperity in the sixteenth century upwards of 100,000 individuals inhabited the district. At any rate, Potosí was, for more than a century, the largest city in the Western Hemisphere. Charles the Fifth conferred on it the title of *villa imperial*, and lovely Sucre, founded a few years before Potosí, was so enriched by the silver from Potosí that it was called the City of Silver (Ciudad de la Plata) up to 1840, when the modern name of Sucre was adopted in honor of that famous general of the War of Independence.

Naturally such a profusion of wealth resulted in the most extravagant displays and elaborate *fiestas*, in fine residences, churches, and public works. All of the wood used in construction had to be brought from the eastern lowlands a great distance away, and anyone who has seen the enormous beams in the old mint, or *Casa Nacional*

de Moneda, can picture the toiling swarms of sweating Indians that were required to transport them over the difficult mountain trails. It is related that one Quiroga, who worked the Cotamitos mine, paid a crown tax of $21,000,000, and from his profits built the cathedral of San Francisco, where his tomb may still be seen. Most of the architecture in Potosí is distinctly Moorish in type, notably the open arcade or flying arches that enclose the east side of the main plaza.

There are three thick old volumes full of tales of Potosí, and the records of litigation that resulted from the old Spanish mining law, which is still in operation at Potosí, would fill a library. Each year, it is said, rival parties smother a few Indians with the fumes made by burning the aji, or native pepper, which some facetious traveler has called the national flower of Bolivia. In the old days rival companies went even further, and at least one rich mine was entirely destroyed by blasts set off by an unsuccessful litigant.

The Mountain, or Cerro Rico de Potosí, to give it its full name, lies south of the town, and its summit is less than three miles from the central plaza. It is a perfect cone of a coarse, igneous rock known as rhyolite, but now so covered with mine dumps from the more than one thousand tunnels on its flanks that the original rock is entirely hidden except at the peak, which attains 15,381 feet, not quite half a mile above the town, which has an elevation of about 13,000 feet. The Cerro truly dominates the town and the surrounding country, as it did Colonial history, and its beautiful ever-changing tints are visible in that arid climate for long distances.

High up on its western flanks it carries tilted lake beds of volcanic ashes, and these are filled with the relics of a rich subtropical vegetation. This proves not only that the igneous intrusion that is responsible for the silver-tin minerals occurred very late in geological time, but that when this one-time lake was filling with ashes blown hither from the far-off volcanoes of the western Andes, the country was more than a mile nearer sea level than it is at present. At that time the moisture-laden winds from the Amazon basin still swept over what is now Bolivia and made it a forested country —the haunt of the mastodon, sloth, horse, and other extinct animals, whereas all is dessication now and not even a mule can crop a meal.

The history of Potosí and of the silver city of Sucre, some forty-seven miles to the northeast (eighty-eight miles by trail), furnishes a superb moral for political economists. I suppose that the original operators in the mountain were for the most part what might appropriately be termed the scum of Spain. Sucre, or Charcas, as it was originally called, was founded in 1538 or 1539 by one Pedro Anzures, Marquis de Campo Redondo, by order of Francisco Pizarro. It lies in a genial basin about 4000 feet lower than Potosí and hence is a delightful place. The ambition of most Potosí operators was to acquire such wealth as would enable them to live in luxury in an appropriate establishment at Sucre. Thus that place came to be known as La Plata, which name it retained for three hundred years.

Sucre early had many and rich ecclesiastical establishments—at the present time with a population of from 20,000 to 30,000 there are thirty cathedrals, convents, and other Church institutions, and their wealth passes belief. The University of Chuquisaca was

chartered the year that the Pilgrims landed at Plymouth and is, next to the University of San Marcos at Lima, the oldest in the Western Hemisphere. It once had a great reputation and drew students from as far away as Buenos Aires, but it is now the Colegio Junin, and a *colegio* is not a college but a secondary school.

Today Sucre is the cleanest, most attractive, most Spanish, and most cultured city of the Republic. The head of the Church and the Supreme Court—those two most conservative organizations of society, are still in Sucre, but all of the other machinery of government is at La Paz. I know of no more impressive instance of the influence of wealth in advancing civilization, or in changing in the course of generations irresponsible adventurers with no respect for law or any form of restraint into conservative citizens, cultivators of literary, historical, and legal studies, supporters of libraries, schools, geographical societies, and a medical school.

Such changes are perhaps a commonplace of history, but nowhere do they stand out as dramatically or more clearly than among the *gente decente*, or aristocrats, of Sucre. Potosí's silver made all of this possible, and Potosí's mines are not only the oldest mines in the world that have been continuously in operation, but they have also produced more riches than any other known mine, and Bolivia may well take pride in them and picture the historic Cerro on its postage.

"The Most Wonderful Plant in the World"

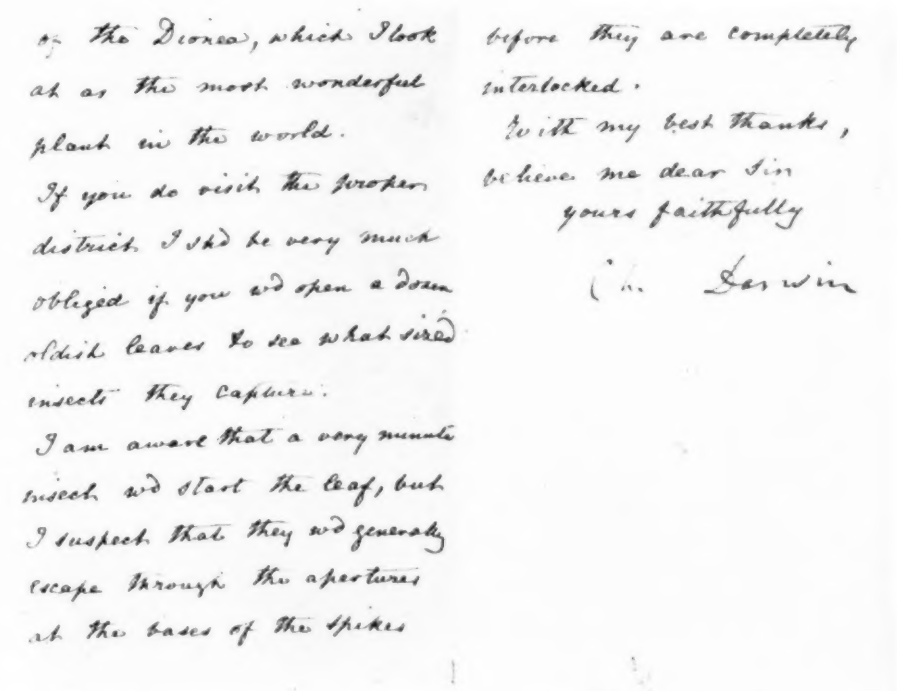
WITH SOME UNPUBLISHED CORRESPONDENCE OF CHARLES DARWIN

By FRANK MORTON JONES

IN 1867 Charles Darwin received a letter from his American correspondent, Asa Gray, enclosing one which Doctor Gray, in turn, had received from William M. Canby, of Wilmington, Delaware. The subject of the Canby letter was the American insectivorous plant, *Dionæa*, Venus's-flytrap; and Darwin's reply says,[1] "This letter fires me up to complete and publish on *Drosera*, *Dionæa*, etc., but when I shall get time I know not." Though he had also written,[2] "I care more about *Drosera* than the origin of all the species in the world," five years elapsed before Darwin was able to resume in earnest his work on insectivorous plants; then, recalling the American botanist as a source of information in regard to *Dionæa*, and admittedly confusing Mr. Canby's home, Wilmington, Delaware, with the habitat of the

[1] *Letters of Asa Gray.* Edited by Jane Loring Gray. Published by Houghton, Mifflin & Co., 1893.

[2] *The Life and Letters of Charles Darwin.* Edited by Francis Darwin. Published by D. Appleton & Co., 1899.



of the Dionea, which I look at as the most wonderful plant in the world.

If you do visit the proper district, I shd be very much obliged if you wd open a dozen oldish leaves to see what sized insects they capture.

I am aware that a very minute insect wd start the leaf, but I suspect that they wd generally escape through the apertures at the bases of the spikes before they are completely interlocked.

With my best thanks, believe me dear Sir

yours faithfully

Ch. Darwin

Dated from Down, Beckenham, Kent, February 19, 1873, this letter from Charles Darwin to the American botanist, William M. Canby, begins with the admission, "I find that I erred in supposing that the leaves never opened a second time. I did suppose that you resided near the habitation of the Dionea [Dionæa], which I look at as the most wonderful plant in the world"

plant, Wilmington, North Carolina, he wrote requesting further information, and especially that field observations should be made on the insect-catching habits of the plant in its native home.

Within the last few months, in a half-forgotten chest in the attic of Mr. Canby's home, this Darwin-Canby correspondence of fifty years ago, relating to *Dionæa* ("which I look at as the most wonderful plant in the world"), has been found. These letters, with the published letters of Darwin and Gray of the same period and regarding the same subject, typically illustrate Darwin's intuitive, almost uncanny, facility in seizing upon apparently minor characters of structure or behavior and in finding there significances hidden from the observers upon whose evidence he builds his edifice of inference and deduction; and they most forcibly call to our attention the paucity in our literature of direct and detailed field observations on *Dionæa*,—if not "the most wonderful plant in the world" yet undeniably among the most remarkable of all our native flora.

Dionæa muscipula, Venus's-flytrap, belongs to the same plant family as the more familiar *Drosera*, the sundews; but while some species of *Drosera* are almost world-wide in their distribution, *Dionæa*, represented by its single species *muscipula*, is confined, if one excepts hothouse specimens, to a narrow strip of about fifty miles along the coast of North and South Carolina; and even within these limits its dis-

Dionæa is not a conspicuous plant, for its leaves rise, at most, only a few inches above the sand, where they are often half-hidden by other herbage

Only when the slender flower stalk raises its cluster of modest white flowers above the level of the leaves, is the discovery of *Dionæa* always possible without prolonged search

tribution is strictly localized, for it seems to be very particular in the selection of its growing place.

To the non-botanical observer, untroubled by problems of comparative morphology, the "leaf" of *Dionæa* is borne on a flattened or winged petiole; the broadly rounded halves of the leaf are set at an upward angle to the midrib, and the outer edge of each half bears more than a dozen evenly spaced finger-like spikes; the slightly concave disk of each leaf-half bears three (sometimes more), fine, short, tapering bristles, which are the "triggers" to set off the trap; for the whole structure

is a trap for the capture of insects. Touch one of the trigger hairs twice, or any two of them in close succession (gently, even with a hair) and like a closing hand the halves of the leaf clap to, the marginal fingers interlace, and if the capture be of nutrient material (an insect), or if it continues its struggles (for the leaf responds both to chemical and mechanical stimulation), the leaf-halves press more and more closely together, the innumerable glands which stud their upper surface pour out an abundant ropy secretion, which bathes the captive in a digestive juice, and when days later the leaf reopens, the insect has been reduced to a mere chitinous shell from which all the softer parts have been dissolved out and absorbed for the nourishment of the plant.

In this photograph one half of the leaf has been removed, to show distinctly the marginal spikes, the three trigger hairs, and the slightly concave and densely glandular area forming the digesting and absorbing surface of the leaf

This is the usual (and apparently justified) interpretation of the activities of *Dionæa*. The mechanism of the closing of the leaf; the conditions under which the digestive liquid is poured out and nutritive material absorbed; even the minute electrical disturbances set up in the leaf in closing,—all these have been made the subject of extended research; but it was in reference to none of these that Darwin wrote Canby. In the closing movement of the leaf one detail had puzzled him. When the trigger hairs are touched and the leaf claps to, it does not at first close tightly; the fingers interlace but do not close to their bases, and a row of crevices remains through which for a time a small insect might squeeze out. Darwin's son actually observed a small ant make its escape in this manner. But after the first quick closing movement, if a capture is actually made, the marginal fingers soon tighten their grip, the leaf edges are pressed into closer contact, and eventually even the form of the imprisoned insect, under the pressure

Why does the leaf of *Dionæa*, in its first quick closing movement, leave a row of crevices between the "fingers," through which a small insect may make its escape, and then very gradually close these orifices? It looks as though the small insects were given an opportunity to escape; but why?

exerted, becomes visible as it bulges out the thin walls. In explanation of these peculiarities of the closing movements of the leaf Darwin had a theory; but his sickly greenhouse plants ("I cannot make the little creature grow well," he wrote[1] Hooker) did not furnish conclusive evidence of its correctness; so his queries to his American correspondent were, "How many times, successively, does a single leaf capture and digest prey? What sized insects do they capture?" Canby replied, writing from memory, six years after his observations had been made: "As to the specific point about the plant capturing large or small insects, the answer is that so far as I am aware it catches everything it can, large or small. . . . As far as I can remember, any insect from the size of a small fly, say a line or two in length, to a beetle or other insect of *nearly* the length of the leaf would be closed upon and . . . devoured. As to the proportion of 'large' or 'small,' I cannot distinctly remember; but after what I have written it would be fair to suppose that within the limits mentioned above it would probably be almost the proportion of insects in the neighborhood of the leaves, except that insects which habitually fly, as a class, would probably be less liable to capture than those which crawl. . . Now about the leaves becoming callous and unexcitable after 'catching' an insect, I have several times known leaves to devour insects *three* successive times, never more than that, and then they were the most vigorous. Ordinarily twice, and quite often once, was enough to render them unserviceable."

This reply was not conclusive, and on February 17, 1873, Darwin wrote Canby: "I find that I erred in sup-

[1] *More Letters of Charles Darwin.* Edited by Francis Darwin. Published by D. Appleton & Co., 1903.

The captures of fifty mature leaves of *Dionæa* consisted of Hymenoptera (wasps and large ants), 10; Diptera (flies), 9; arachnids (spiders), 9 (one with an egg sack); Coleoptera (beetles), 9 (each distinct as to species); Orthoptera (grasshoppers, locusts, roaches), 7; Hemiptera (predacious bugs and leaf hoppers), 4; Lepidoptera (caterpillars), 2. The average length of the fifty victims was 8.6 mm., or about one third of an inch

posing that the leaves never opened a second time. . . If you do visit the proper district I shd be very much obliged if you wd open a dozen oldish leaves to see what sized insects they capture. I am aware that a very minute insect wd start the leaf, but I suspect that they wd generally escape through the apertures at the bases of the spikes before they completely interlocked."

And again on May 7 of the same year Darwin wrote: "I thank you very sincerely for the leaves, of which I have examined the [captures] with great interest. The results support my anticipation that the leaves are adapted to allow of the smaller fry escaping. Eight of the fourteen leaves had caught beetles of relative considerable size. There were also a good-sized spider & a scolopendra. Three of the leaves had caught ants. I wish the leaves had been of full size, but I think my results may be trusted."

The examination of the captures of fourteen small leaves, then, is the principal basis upon which Darwin builds his theory of the significance of the initial partial closing of the leaf of *Dionæa*. In *Insectivorous Plants* he reviews this evidence, concluding, "It would manifestly be a disadvantage to the plant to waste many days in remaining clasped over a minute insect, and several additional days or weeks in afterwards recovering its sensibility; inasmuch as a minute insect would afford but little nutriment. It would be far better for the plant to wait for a time until a moderately large insect was captured, and to allow all the little ones to escape; and this advantage is secured by the slowly intercrossing marginal spikes, which act like the large meshes of a fishing net, allowing the small and useless fry to escape."

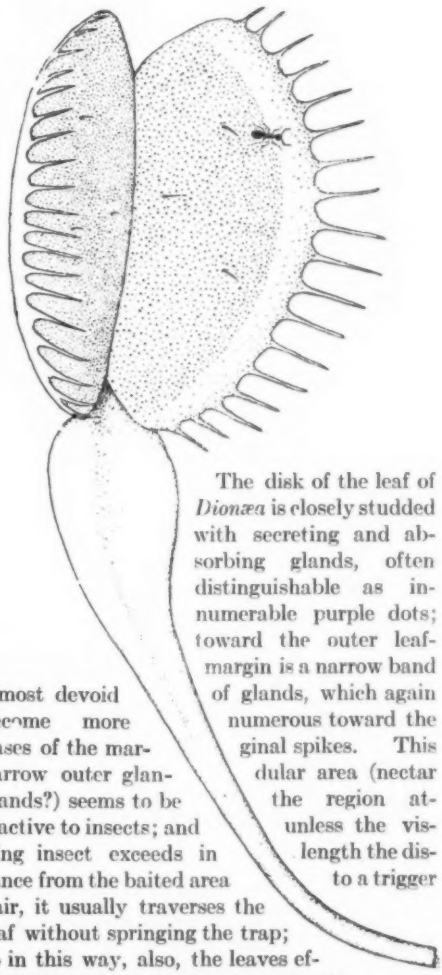
Before the appearance of *Insectivorous Plants* Gray wrote to Canby thus:[1]

[1] *Letters of Asa Gray.* Edited by Jane Loring Gray Published by Houghton, Mifflin & Co., 1893.

"Conundrum? Why does the *Dionæa* trap close only part way, so as to cross the bristles of edge only, at first, and afterwards close fully? Darwin has hit it. I wonder you or I never thought of it. . . Think what a waste if the leaf had to go through all the process of secretion, etc., taking so much time, all for a little gnat. It would not pay. Yet it would have to do it except for this arrangement to let the little flies escape. But when a bigger one is caught he is sure for a good dinner. That is real Darwin! I just wonder you and I never thought of it. But *he* did." Gray was right, and "That is real Darwin!" But is it true? Darwin, after examining the captures of fourteen leaves gathered in the field, writes, "I think my results may be trusted." Perhaps by these methods his theory of this significance of the leaf behavior is not susceptible of absolute proof; but it seemed worth while, by further direct observation upon the plants in their native home, and by the examination of a large number of leaves which had made captures, to determine whether an actual sorting out of visiting insects by size does take place.

On May 31, 1921, *Dionæa* was found in full bloom, in abundance, and in fine condition, within a few miles of Wilmington, North Carolina. It was an easy task to gather fifty well-developed leaves with captures; these were opened carefully, and their captures were dropped into alcohol, for measurement and approximate identification at leisure. Of the fifty, only one was less than 5 mm. in length, and only seven, less than 6 mm.; ten were 10 mm. or more in length, with a maximum of 30 mm. We may then safely conclude that the habitual captures of mature leaves range from the largest insect the leaf is able to close upon and hold, down to those approximately one quarter of an inch in length; and that insects materially smaller than this, if they spring the trap, usually take advantage of the opportunity afforded by the partially closed leaf and make their escape.

One capture not tabulated deserves special mention. When one leaf was opened, its contents were found to be a single wing cover of a large beetle (shown in the center of the plate of captures) and an ant much smaller than any of those captured by the other leaves examined. It is not diffi-



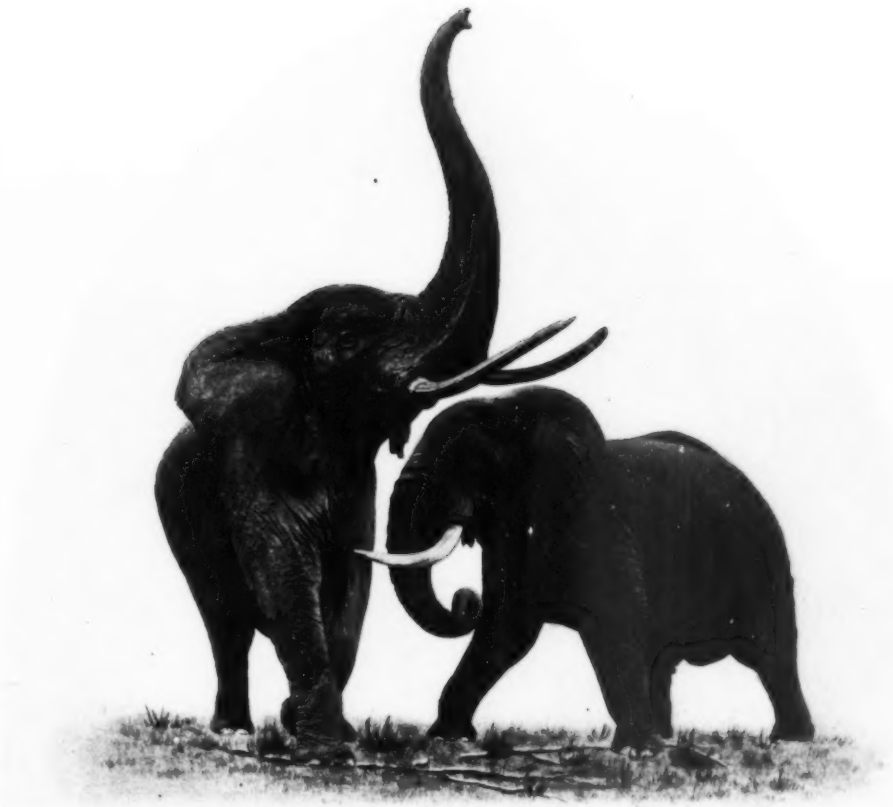
The disk of the leaf of *Dionæa* is closely studded with secreting and absorbing glands, often distinguishable as innumerable purple dots; toward the outer leaf-margin is a narrow band of glands, which again almost devoid numerous toward the become more ginal spikes. This bases of the mar- dular area (nectar narrow outer glan- the region at- glands?) seems to be unless the vis- tractive to insects; and iting insect exceeds in length the dis- tance from the baited area to a trigger hair, it usually traverses the leaf without springing the trap; so in this way, also, the leaves effectively sort out their captures by size

cult to picture the minute ant, desperately tugging the wing cover across the leaf, bumping into the trigger hairs, and refusing to desert its booty until the time for possible escape had passed.

With this evidence of the size of the actual captures of the leaves, it was desirable to determine what insects could be observed upon the leaves, subject to capture; and parts of two days were devoted to this, with some unanticipated results. Ants were the only insects frequently noticed upon the leaves. Nearly all of these ants belonged to small species, 3 mm. or less in length, and consequently smaller than any of those captured by the fifty leaves. None was actually observed to set off the trigger hairs, but we repeatedly sprung the leaf traps with slender grass stems without disturbing the ants, each leaf closing upon its visiting ant, which crept out after the expiration of a few seconds, either between the crossed fingers, as Darwin had surmised and recorded, or at the end of the leaf, where also a slight crevice remains after the first closing movement; and none failed thus to make its escape in time to elude the slow tightening and closing of these apertures.

The plants *were* sorting out their captures by size; but to accomplish this not one method, but two, were employed; and the second and unrecorded method with respect to these small ants was the more effective. Most of these little ants (sometimes two of them on a single leaf) were observed to occupy a uniform position on its upper surface, their heads close to the bases of the marginal spikes. As they moved slowly across this belt of the leaf, they made frequent and prolonged pauses, during which, their mouth parts were observed under the lens, to be in motion against the surface of the leaf. A larger and winged hymenopteron was observed to be engaged in the same performance. Obviously, they were feeding upon some attractive exudation of the leaf. The behavior of visiting insects is entirely convincing to the observer that a baited area extends across the leaf on its upper surface just within the bases of the marginal spines. This baited marginal band is so situated upon the leaf surface that a visiting insect *in length too small to extend from the bait to the trigger hairs*, usually does not spring the trap. Whether or not these conditions are to be interpreted as adjustments to that end, the effect of this arrangement, in conjunction with the peculiarities of the closing movement by which small insects are given an opportunity to escape, is to limit the usual captures of the leaves to insects approximating one quarter of an inch or more in length.

Living plants of *Dionæa* were exhibited in England more than 150 years ago, even prior to the first published description by Ellis (1775). The voluminous literature of research upon this plant has increased rather than decreased our recognition of its almost unique interest, and is at least proof that *Dionæa* still withholds answer to some of its more fascinating problems. As a hothouse plant it continues to be fairly familiar both here and abroad, but its survival in its restricted native habitat should not be left to chance. Let us hope that means for its preservation may be found, and that for all the future we may have opportunity to "look on *Dionæa* as the most wonderful plant in the world."



Elephants mounted for the Field Museum in 1907–08 by Carl E. Akeley

How Elephants are Mounted

A CHAPTER IN THE HISTORY OF TAXIDERMY

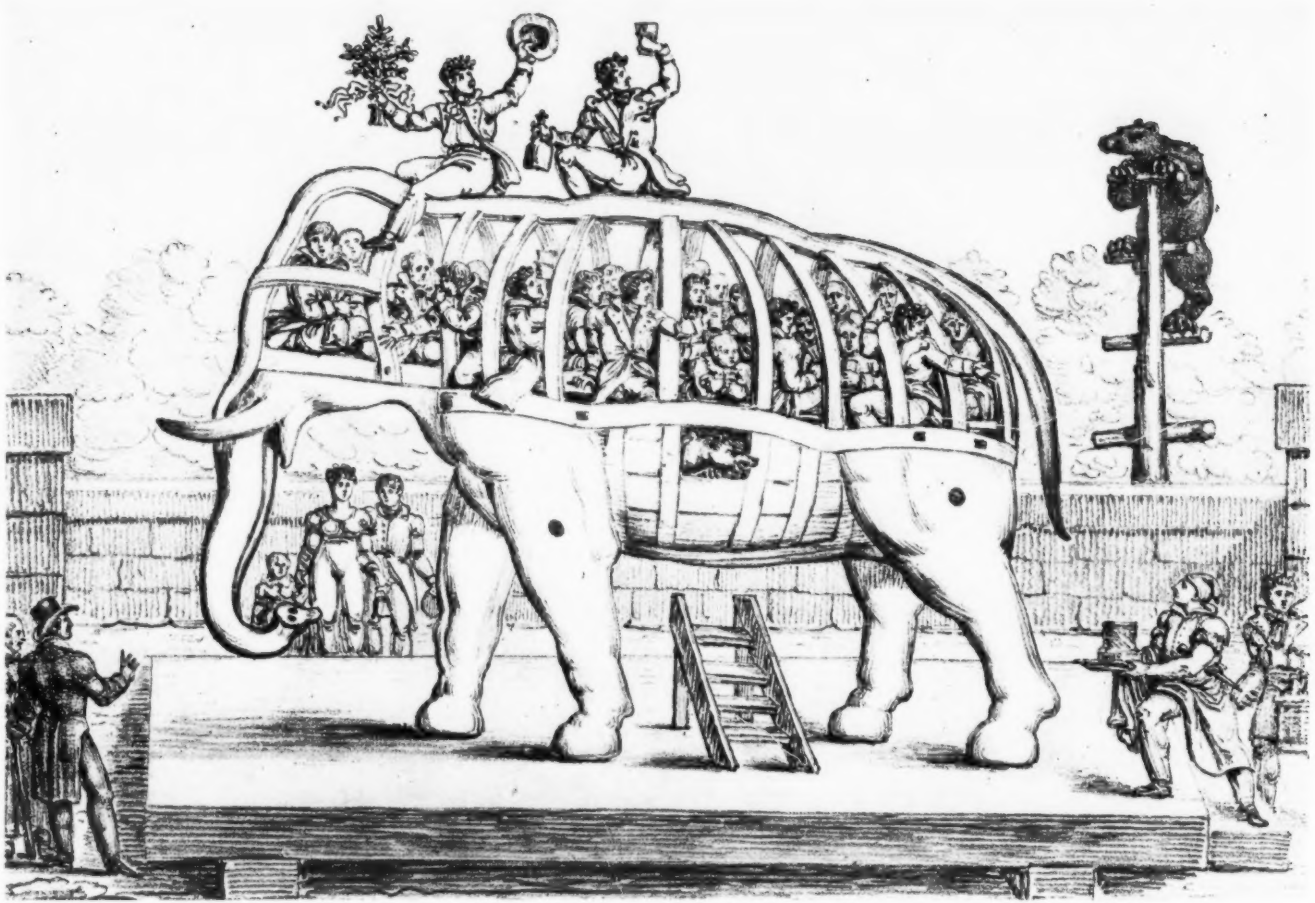
By FREDERIC A. LUCAS

Dr. F. A. Bather, deputy keeper of geology, British Museum, in noticing in the *Museum's Journal* of Great Britain the statement that Director Lucas prepared for the *Fifty-third Annual Report* of the American Museum, expressed the wish that Mr. Akeley's new method of mounting elephants, which is applicable also to other large pachyderms or short-haired mammals, had been described.

That it was not was due partly to the fact that it did not at the time occur to Director Lucas to write a disquisition on taxidermy, and partly from a desire to make the report as brief as possible. It is hoped that the present article may serve as a record of how various elephants have at various times been mounted by various preparators and that Mr. Akeley may in short time be able to prepare a detailed account of his method for the guidance of others.

MOUNTING an elephant is not only the largest but in many ways the most difficult problem with which a taxidermist can be confronted, and it is interesting to note the various ways in which the problem has been met and what appears to be its solution. Just when the first elephant was mounted I know not, but some time before 1813 one was on exhibition in Bullock's Museum, London: unfortunately we have no record of the method employed in mounting it.[1] This is all the more regrettable because it must have been one of the earliest, possibly *the* earliest, example of a

[1]This specimen is shown in an aquatint of Bullock's Museum, and is noted in the *Companion to Bullock's Museum* issued in 1813, but while the eighth edition of the *Companion*, 1810, devotes three pages to the "Artificial Forest," which includes a lengthy description of the rhinoceros, it makes no mention of an elephant.



CELEBRATING THE MAKING OF THE MANIKIN

This spirited picture—a reproduction of a lithograph preserved in the Musée d'Histoire Naturelle, Paris—shows a festive gathering held in the manikin which M. Lassaigne, artificer employed in the Jardin du Roi, made in 1817 for the skin of a female elephant

mounted elephant, though as Hanno brought to Carthage skins of the gorilla (?), some ambitious Roman may have preserved the skin of one of Hannibal's elephants.

Not long after the above-mentioned date, however, in 1817, we have a detailed account of the mounting of one of these big pachyderms for the Jardin du Roi—now Musée d'Histoire Naturelle—and what is more, we have a picture of how it was done. Capt. Thomas Brown, whose *Manual of Taxidermy*[1] ran through more than twenty editions has given a rather detailed account of the method employed by Lassaigne, the preparator; he tells us that:

> The model which was to fill the skin was made as perfect as possible in its shape. To insure this, models were made of half the head in plaster, as also a fore and hind leg. This structure was made of linden wood, and so ingeniously constructed by M. Lassaigne, that almost the whole parts could be separated. He opened a panel on one side of the body, whereby he introduced himself into its interior, so that he might make its parts more perfect within. Even the head and proboscis were hollow, which rendered this stupendous model so light that it could be moved from one part to another with comparative ease.
>
> The model being completed, the alum water in which the skin had been all the time immersed, was now taken out and made boiling hot, and in that state poured on the skin, which was then allowed to soak in the warm liquor for an hour and a half, when it was taken out still warm and placed upon the model, which they accomplished with some difficulty. But judge of their mortification when it was found that the model was rather too large. To diminish the wood-work they foresaw would run the risk of putting its parts out of proportion. It then occurred to them, that the best thing to be done under these awkward circumstances, was to take off the skin again and reduce its thickness with knives; they removed all the internal thickenings which came in their way. In this operation five men were occupied for four days, during which time they cut out one hundred and ninety-four pounds weight of the internal surface. During this process the skin had dried, and required again to be immersed in cold soft water; after allowing it to remain twenty-four hours to soak, it was then put on the model and found now to cover it completely; the edges were brought together, and secured with wire nails deeply driven home, and large brads. Except at the edges, the nails and brads were only driven in halfway to keep the skin down to the different sinuosities and hollows until dry, when they were again all pulled out.
>
> The alum with which the water was saturated gave the skin an ugly gray appearance, in consequence of its becoming crystallized. But this was soon remedied, by first rubbing the skin with spirit of turpentine, and afterwards with olive oil.
>
> By the admirable and well executed contrivance here adopted, a specimen has been mounted with all the appearance of life, which, with a little attention, may resist for ages the influence of Time's destroying hand. It is the only specimen of an Elephant in Europe worth looking at, all others being great misshapen masses, completely devoid of all appearance of nature.

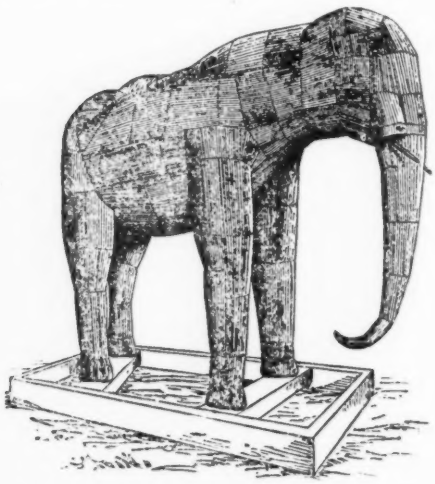
M. Didier tells us[1] that after the lapse of a century the specimen is absolutely intact: in fact, it is the most prominent feature in the postcard giving a general view of the large exhibition hall of the Musée d'Histoire Naturelle. This durability is the more remarkable, for the skin was alum-tanned and in our climate a specimen so treated is apt to go to pieces in a few years; some credit must be given, therefore, to an equable climate and unheated exhibition halls.

This was not the earliest use of a wooden manikin for Mr. Didier records that during the reign of Louis XVI a quagga was so mounted by some artist

[1] What has become of all the copies of Brown's *Manual?* Apparently it was the most popular book on taxidermy ever printed. for McCormick notes that there were twenty English editions and several reprints in the United States. And yet it is difficult to get a copy; there is none in the library of the Manchester Museum, whereof Brown was director for several years, none in the library of the Zoological Society nor in that of the British Museum.

[1] *L'Art de la Taxidermie au XX^e Siècle*, p. 11.

whose name has apparently not been preserved, but it seems to have been the first instance of the employment of such a manikin on a large scale. It is to be noted also that Charles Willson Peale mounted some of his short-haired mammals over manikins or forms carved out of wood, doing this, he tells us, to reproduce the muscles as they would be in life.



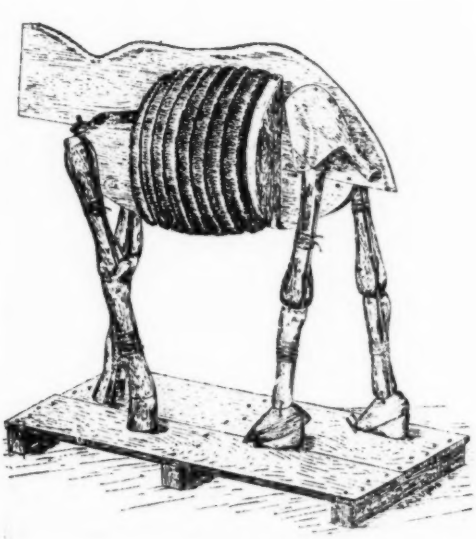
The wooden manikin of Jumbo, the most celebrated elephant of modern times

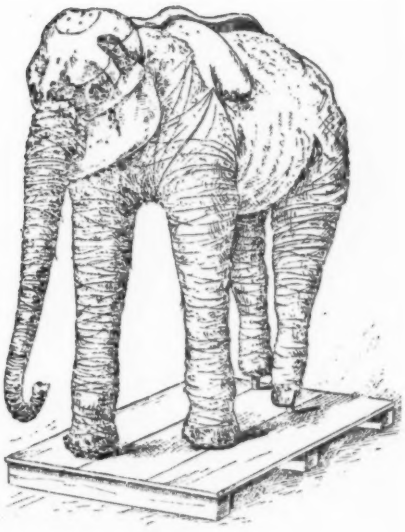
Why, it may be asked, did not Peale devise the simpler, quicker method of modeling in papier-maché and thus anticipate Akeley? This conundrum cannot be answered definitely but it is possible—even highly probable—that lack of materials had much to do with it. There was no wire cloth in those days, paper was scarce and costly, and plaster, we imagine, had to be imported; shellac was unknown—even nails were expensive as they were all made by hand and they were clumsy affairs at best. I remember well my contempt for English hand-made "sprigs" and my longing for machine-cut brads when I was doing a little carpentry in 1869. The modern preparator has no idea of the handicaps under which his predecessors labored; if he had, he would perhaps marvel at what they did accomplish.

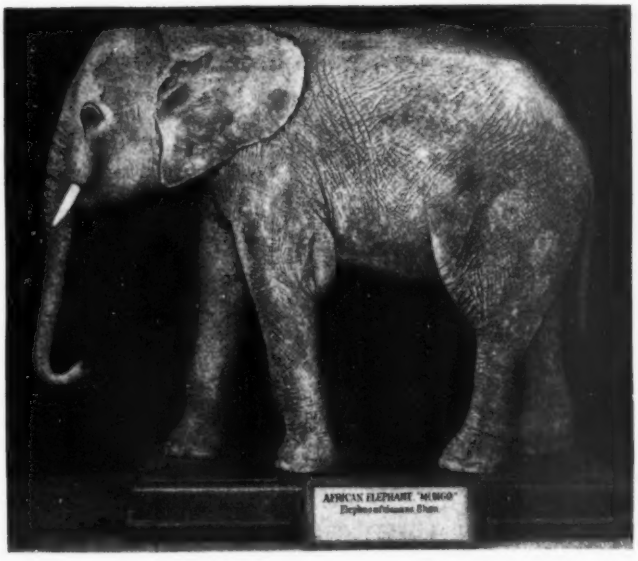
Just about a life span later, in 1886, Jumbo, the most celebrated elephant of modern times, was mounted by Critchley and Akeley over a wooden manikin in a manner very similar to that practiced in 1817—thus does history repeat itself. It is to be noted that in the case of Jumbo it was necessary to provide for rough handling as the mounted skin and skeleton for more than a year formed part of the attractions of the "greatest show on earth" and Jumbo's "counterfeit presentment" was drawn around the arena as a part in the procession of which he was once the chief ornament. The skin and skeleton of Jumbo, once so closely united, have been in death widely separated—the mounted specimen forming the central feature of the museum at Tufts College, while the skeleton, with its original mountings, is on exhibition at the American Museum.

Still another method was adopted by Doctor Hornaday for the mounting of Mungo, a small African elephant belonging to the Barnum "Shows," that died accommodatingly in Washington in 1882, shortly after Doctor Hornaday had become connected with the United States National Museum. In this instance a manikin of excelsior was built about a skeleton of wood and iron and over this, faced with clay to take the imprint of wrinkles, was placed the skin. Mungo is still to be seen in the United States National Museum.

Later, in 1907–08, the pair of African elephants in the Field Museum was prepared by Mr. Akeley, who used in this case still another



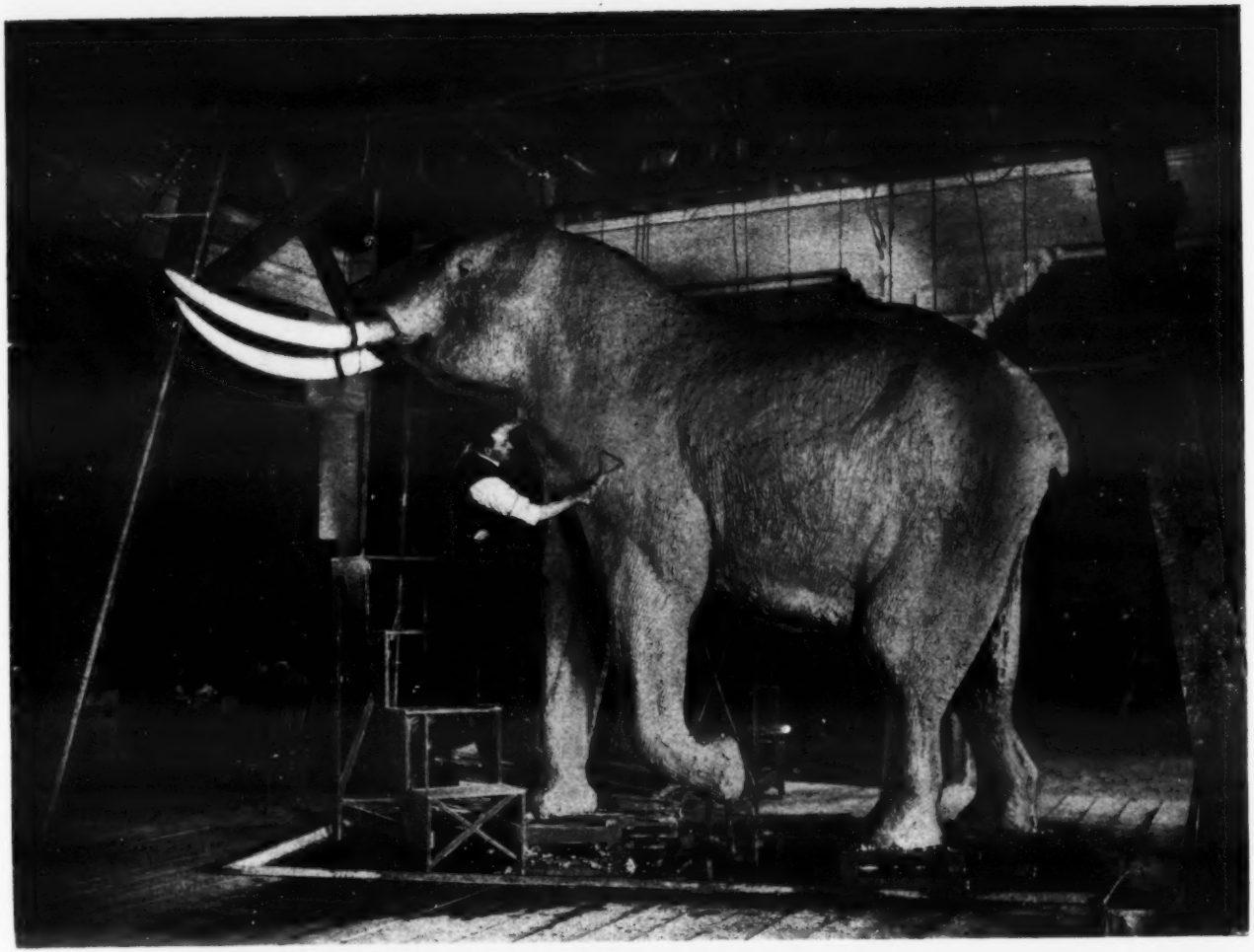




THREE STAGES IN THE RE-CREATION OF MUNGO

The illustration in the upper left of the page shows the wood-and-iron core of the manikin. To this framework excelsior wrappings were added, so that the manikin might have the necessary bulk and fullness of contour as indicated in the picture in the upper right. In this picture the wooden skull and protruding backbone may be readily differentiated from the parts that are of lighter construction material. The completed elephant is shown below.

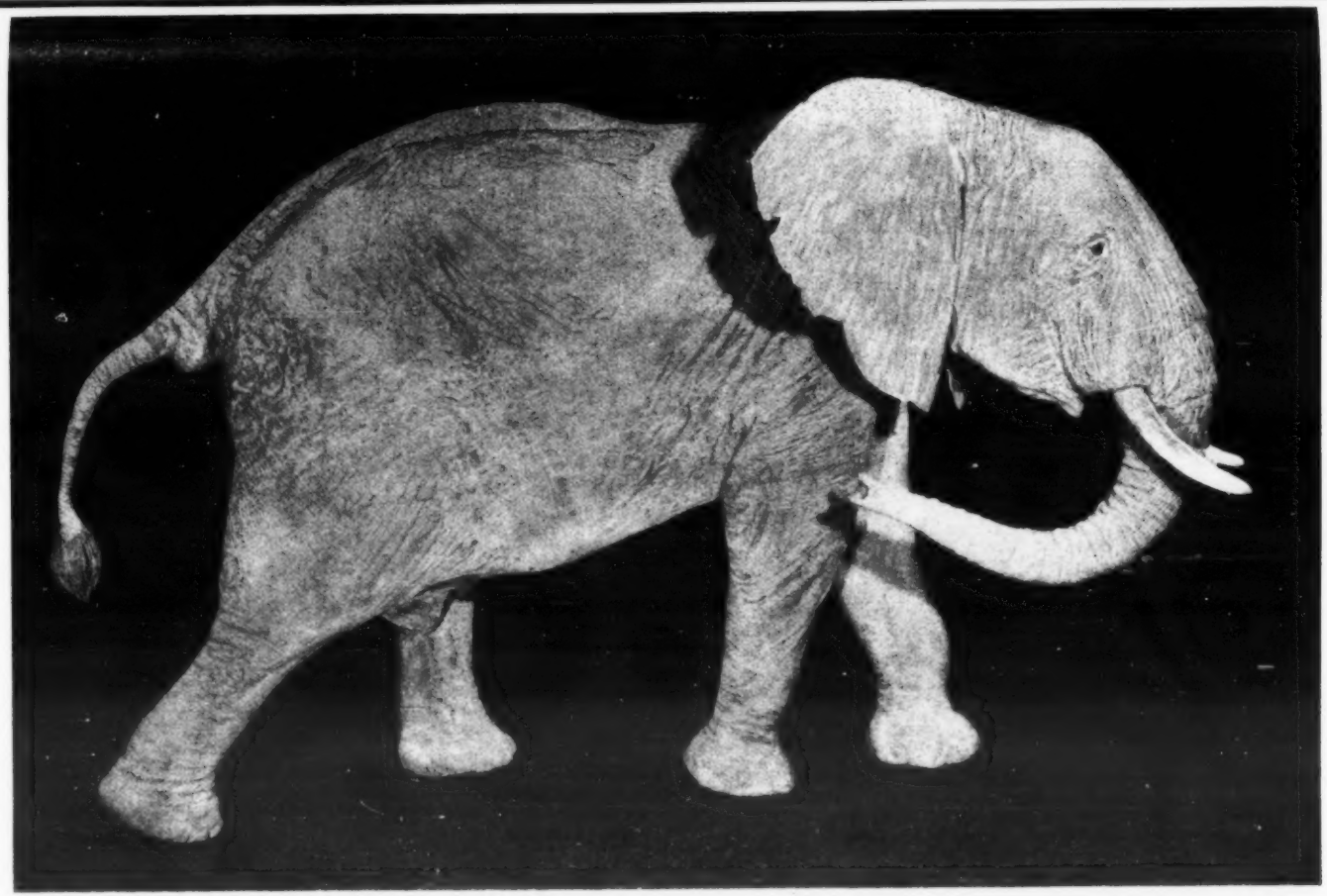
Mungo, like the more famous Jumbo, was one of the elephants that contributed to the spectacular appeal of the "greatest show on earth." In 1882 Mungo died and passed from the circus arena into the possession of the United States National Museum, where the mounted elephant still attracts the attention of visitors as the living animal once drew the gaze of the circus crowds



MR. CARL E. AKELEY
AT WORK

Mr. Akeley has done much to revolutionize the methods of taxidermy and elevate it to the level of an art. He is here seen in his atelier in the American Museum perfecting the clay model of an elephant. Extraordinary care must be taken by the artist in the preparation of the model, for it is not a case of adjusting the skin to the manikin but of adjusting the manikin to the skin.

This is but one of the stages in the process of mounting elephants as devised and perfected by Mr. Akeley, a process which assures in the completed specimen not only accuracy of detail and an astonishing similitude to the living animal but durability, lightness, and strength. A brief outline of the process is given in the article



ONE OF THE FINEST EXAMPLES OF MR. AKELEY'S ART

This superbly mounted tusker, with its alert attitude of preparedness for whatever danger may threaten, is an impressive member of the group of elephants mounted by Mr. Akeley for the prospective Roosevelt African Hall of the American Museum

method, that of the manikin modeled in plaster on a framework of wood and wire cloth, in which were reproduced all the muscles and larger wrinkles of the living animal. The skin was fastened to the manikin by a thin layer of plaster, mixed with glue to make it dry slowly, and in this were modeled the finer details. A modification of this process, used by Mr. Akeley and also by Mr. Turner with great success in mounting large mammals other than the elephant for the United States National Museum, consists in modeling in papier-maché on a framework of wood and wire cloth that roughly approximates the form of the animal to be mounted. From the readiness with which changes can be made in such a manikin during its construction, it is particularly applicable to skins without measurements.

In 1914 when Mr. Akeley began his group of elephants in the American Museum he started with a new plan, that of modeling the skin of the animal over clay in which all folds and wrinkles could be impressed, backing the skin with plaster and transferring it to a frame of lattice work, whose interstices would be filled with wire cloth and papier-maché.

This plan was carried out only with the little Toto, for while working on this, Mr. Akeley conceived still another method, so that while the lattice framework was actually made for the female elephant, it was used only as an armature for the clay model—presently to be described—and this specimen was modeled in separate halves. For the information of the reader not versed in methods of collecting and in the art of taxidermy—for it is now an art—it may be said that such bulky beasts as elephants are skinned in sections, the head being cut off in one of the deep neck wrinkles, and each side skinned and treated separately.

The new and latest method, as worked out by Mr. Akeley in the instance just referred to, consists in modeling the animal in clay, placing the skin on this clay body, and working directly on the skin, impressing its folds and wrinkles into the yielding clay. This of course insures accuracy of form and detail. If the clay form is not correct, the skin will not fit it, while the wrinkles *must* be put in exactly where they occur. It is not a matter of adjusting the skin to the manikin, but of adjusting the manikin to the skin, and any mistake in modeling is glaringly apparent. The skin, like Gaul, is divided into three parts, the head and the two sides, but they are assembled on the clay figure, though details of the head and trunk are executed later.

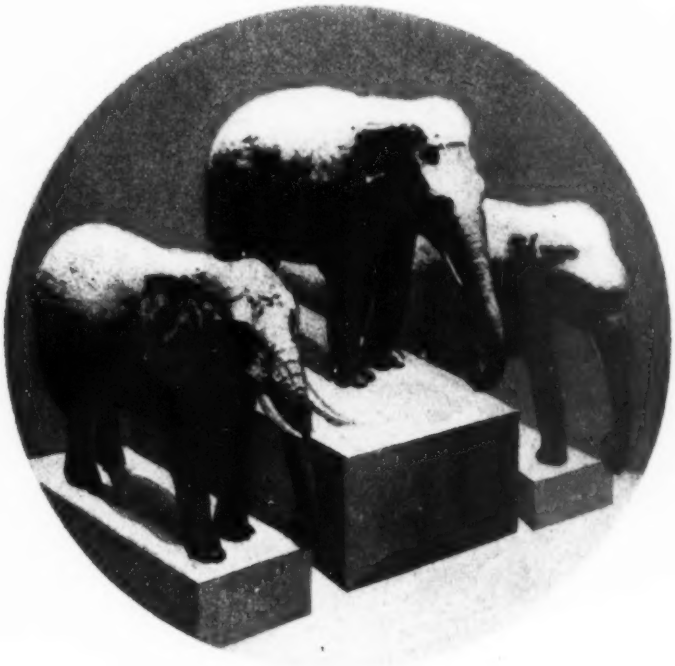
When the modeling has been completed, the body is covered with a plaster jacket, the sides are separated and laid flat, and the clay is removed. The skin is then lying in the plaster jacket, or rather jackets, and when it is dry, it is shellacked and lined with a thin layer of papier-maché, backed with wire cloth, strengthened where needed with light wooden braces. The two halves are then assembled, the head placed on the body, the skin treated with a thin coat of wax.

This is the merest outline of the process, and takes no account of the details of skin preparation and the technique of the various elements of the process or of the engineering problems involved in the construction.

Mr. Akeley's latest method seems the final word in mounting big pachyderms, combining as it does accuracy of form with strength, lightness, and, above all, durability in the finished pieces. It is

slow work but the time-consuming part of the task can be done by comparatively unskilled assistants, and the result is a specimen that will not only give the thousands who will never have a glimpse of Africa an opportunity to see what an elephant really looks like, but that also will serve as a criterion of size and stature after all large elephants have been blotted from the face of the earth.

Finis coronat opus



The central figure in this group of elephants from the Musée d'Histoire Naturelle of Paris is the specimen mounted by Lassaigne in 1817. The making of the manikin of this elephant was rather novelly celebrated as indicated in the picture on p. 598.

The Department of Fishes, American Museum

ITS AIMS AND ACHIEVEMENTS

By BASHFORD DEAN
Honorary Curator of Ichthyology

THE department of ichthyology is one of the newer departments of the American Museum, dating from 1909, when it branched out of the department of invertebrate zoölogy, bringing with it the reptiles and amphibians which until then had remained in care of the older department. The writer, who had been in charge of fossil fishes in the department of vertebrate palæontology since 1904, was the first curator of the new department, which was to care for both recent and fossil fishes. As the department of ichthyology and herpetology it remained until 1920, when the amphibians and reptiles were set apart as the department of herpetology under the curatorship of Miss Mary C. Dickerson.[1]

The personnel of the department of ichthyology has been as follows:

Bashford Dean, Ph.D., professor of vertebrate morphology at Columbia University, curator from 1907–14, and honorary curator since 1914.

Louis Hussakof, Ph.D., assistant and associate curator, 1909–13; curator, 1914–16.

John T. Nichols, A.B., assistant, and since 1910 associate curator.

O. P. Hay, Ph.D., assistant curator of fossil fishes, 1903.

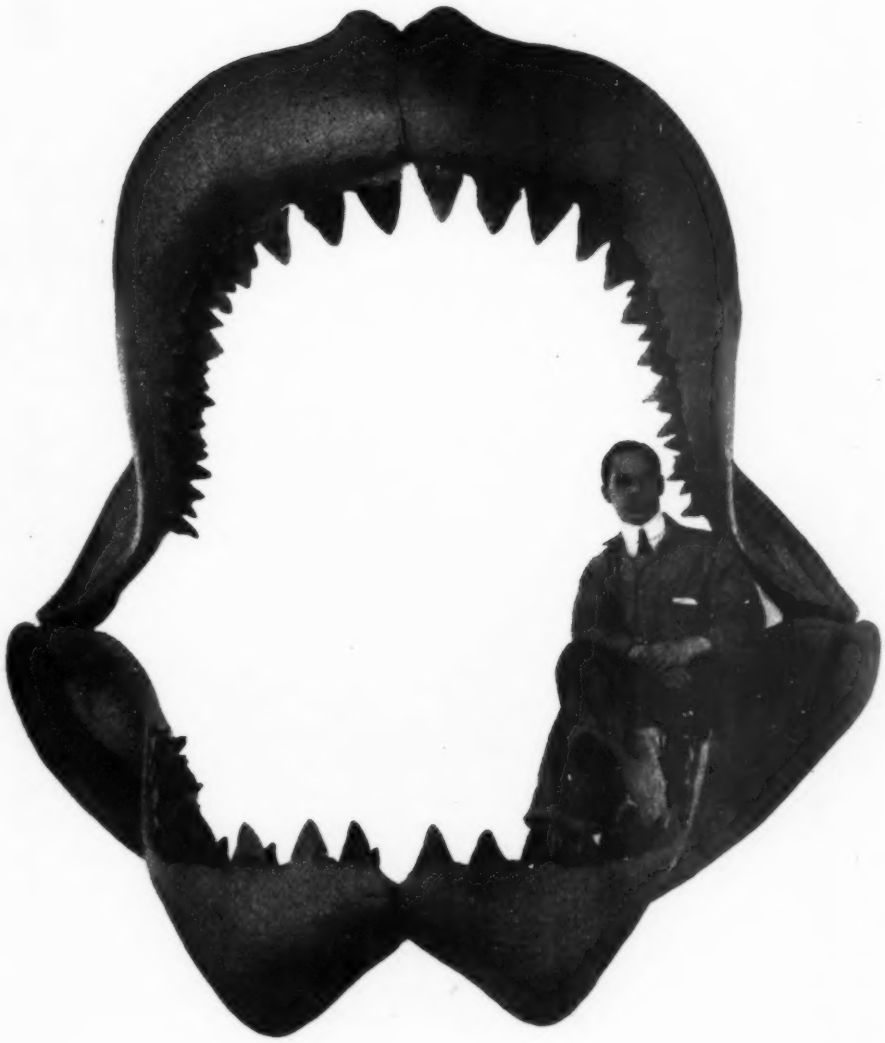
C. R. Eastman, Ph.D., editor of the *Bibliography of Fishes*, 1914–17.

E. W. Gudger, Ph.D., editor of the *Bibliography of Fishes* since 1919 and associate since 1921.

Arthur W. Henn, A.B., associate bibliographer in connection with the *Bibliography of Fishes*, 1916–22.

The earliest materials of the department of ichthyology were scanty,—an aggregation of uncatalogued dried, alcoholic, and stuffed specimens, which had been housed in one of the basement rooms of the Museum. As the exhibition of fishes, there had been shown up to that time little more than a few stuffed specimens together with a case of casts, which had come to the Museum from the United States Fish Commission in the days of Commissioner Baird. The newly organized department laid out a far-reaching plan of development. It aimed to exhibit in its galleries representatives of all of the principal groups of fishes, fossil as well as living. It designed a series of habitat groups which were to show the visitor how fishes live and move and have their being. It planned many exhibits to show the development of typical fishes from the earliest stages of the egg until the young have attained adult form. It outlined case exhibits planned like genealogical charts to tell even a casual visitor where the earliest backboned animals came from and how in time they developed into modern fishes. It had in mind to clear up mooted points through study in the laboratory of material obtained by expeditions sent to many parts of the world. It had, finally, the wish to bring together effectively a knowledge of all the extensive literature, old and new, which concerned fishes, so that anyone who here sought information could obtain it with minimum effort in the least space of time. In twelve years these lines of development of the department have led to encouraging results.

[1] In a later issue of NATURAL HISTORY will be printed an account of the department of herpetology.



A model of the jaws of the huge *Carcharodon angustidens*, set with actual fossil teeth. There were no human beings to devour when this mighty relative of the existing white shark swam the seas

The Collection of Fossil Fishes

The department first succeeded in obtaining from Columbia University as a quasi-permanent loan the collections of fossil fishes brought together by the greatest American palæichthyologist, Prof. John S. Newberry, constituting, in fact, almost his life work. These included the fossil fishes of North America with nearly all his described and figured specimens, many of them of great value for popular exhibition. So it came about that the department was soon able to install a gallery in one of the corner rooms of the Museum which reviewed the past history of

fishes and showed the impressionable visitor veritable monsters of ancient seas. This collection was amplified not long after by the fossil fishes which had been brought together by Professor Cope, whose private museum President Osborn had triumphantly secured for the American Museum. With these two accessions, rounded out by careful purchases and by the material collected by several expeditions, the department was able to illustrate the early fishes of the world in a way second to that of no museum on this side of the ocean and excelled by but few foreign museums. To house this collection, catalogue it, and systematize it, proved no small undertaking for the young department.

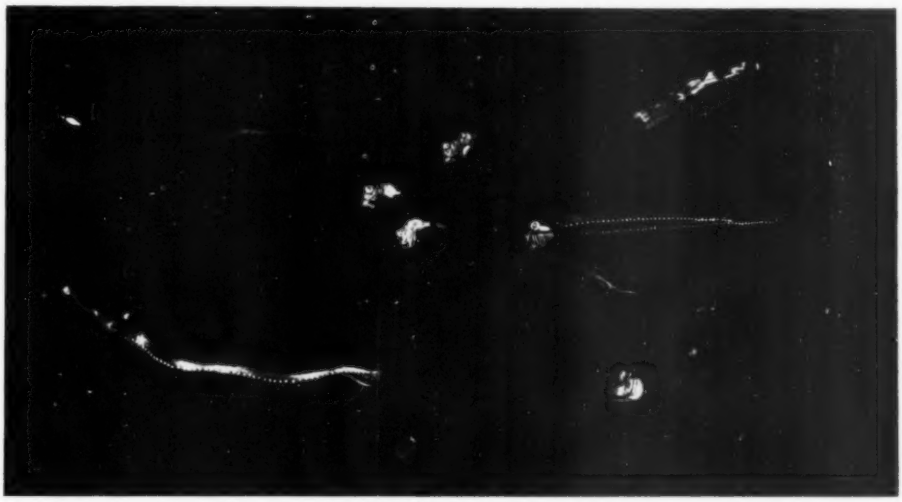
It was in connection with this work, and for the purpose of giving popular instruction, that there was prepared an interesting series of restorations and models, and a case built to resemble an aquarium with models of fossil fishes therein. At this point we may note the restoration of *Dinichthys*, a giant "fish" that lived in the Devonian seas of Ohio, and a life-size model of the jaws of the big-toothed *Carcharodon*, the "man-eating" shark of the past, set with actual fossil teeth gathered from the phosphate beds of South Carolina. This extinct shark is the most formidable fish known; it reached a length probably of eighty feet. In the interest also of the collection of fossil fishes were undertaken the expeditions to Canada, Ohio, and Kentucky; these expeditions, as well as the purchase of much of our material, were made possible by generous gifts to the department by Mr. Cleveland H. Dodge.

THE EXHIBITION OF RECENT FISHES

In the preparation of a large popular exhibition of typical forms of living fishes the department found its greatest difficulties. In the first place, fishes are among the most unsatisfactory creatures to mount for general view, and even when they were satisfactorily prepared, there was to be had in the overcrowded Museum but little space in which a suitable series could be shown. We were able at length to share a gallery with the department of birds. We also utilized a back hall that led to certain of the Museum workshops. We were not entirely disheartened, however, for we had room in which to exhibit some fishes that from the viewpoint of popular interest or as representatives of great structural groups had special claims to attention. Here we placed on view stuffed specimens or models from materials which we gathered from many sources. In our limited space we had hard work to show even a few of these monsters of the sea which public exhibition ever demands. To obtain them, several expeditions were sent out, to Florida especially. These undertakings yielded excellent results for the enrichment of our gallery, so that now the visitor may see in lifelike poses and colors casts of sawfishes and swordfishes, sharks of various kinds, the giant devilfish (*Manta*), the great sea sunfish (*Mola*), and even the great pike-like *Arapaima* of the Amazon, the largest living member of the bony fishes of the world.

The former exhibits were in a degree diagrammatic, for who can picture a fish adequately from a dried specimen or from a painted cast? Habitat groups were needed which would show typical fishes in their natural surroundings, breeding, brooding, or feeding. But here, again, we encountered numerous difficulties. Few museums had attempted such a work and a new tech-

nique had to be developed before the visitor could be given the illusion of viewing under-water life. The careful attention given to this subject by Mr. Dwight Franklin, then in the Museum's department of preparation, enabled us to take the first steps in the direction of portraying groups of fishes adequately. From that time, thanks to the devoted work of Mr. F. F. Horter, we continued to add important "habitats" to the series. We now illustrate the life habits of representatives of all the more important groups of fishes, from the lowly lampreys through the sharks and ganoids, including the bony gar pike (*Lepisosteus*), the long-nosed *Polyodon*, or spoonbill sturgeon, and the bowfin (*Amiatus calvus*) up to certain modern fishes. Of striking interest is a group showing a blue shark, lolling in Gulf Stream waters, surrounded by a brood of young. The eggs of this shark, like those of most modern sharks, hatch within the body of the mother, the young fishes being born of good size, adult in form, and quite able to fend for themselves. Of great popular interest is a case representing certain fishes from the deep sea which like the luminous beetles known as fireflies have evolved their own sources of light. In these models, phosphorescent organs have been imitated by artificial lights, which appear intermittently, very much as, it is believed, they occur in the depths of the sea. We have not as yet been able to show a series of our local fishes. By courtesy of Director Lucas, some of the more prominent of them have, however, been mounted in special cases near the Museum elevator apart from the main collections.



A detail from the group of luminiferous fishes that exist in the sunless black depths of the sea. Models prepared and mounted by Mr. F. F. Horter under the supervision of Dr. Louis Hussakof

THE NEW HALL OF FISHES

The new hall of fishes, which will be opened probably in the spring of 1925, will, in the nature of things, mark an epoch in the usefulness of the department. Hitherto, as above indicated, the exhibition of fishes has had but a

THE PADDLEFISH GROUP

A school of paddlefish (*Polyodon spathula*) is seen entering the seine of a fisherman. This fish, which may attain a length of 6 feet and a weight of 160 pounds, is known only from the Mississippi and near-by waters. Its nearest existing relative is found at the opposite side of the earth, in China. The paddlefish is a true sturgeon but one that has undergone many changes. It has lost entirely its armor of bony plates and has developed a paddle-shaped snout, the true function of which is still in dispute.

The paddlefish (or spoonbill sturgeon, as it is not infrequently called) and the gar pike (*Lepisosteus osseus*) in the upper left of the picture represent a nearly extinct group (ganoids), which gave rise to most of the kinds of existing fishes.

The present group was made possible through the generosity of Mr. Cleveland H. Dodge. The materials for it were secured in 1910, at Moon Lake, Mississippi, by a Museum expedition in charge of Dr. Louis Hussakof. The paddlefish were cast by Mr. Otto Block from molds made in the field by Mr. Dwight Franklin The gar pike was mounted by Mr. F. F. Horter. The background was painted by Mr. Albert Operti

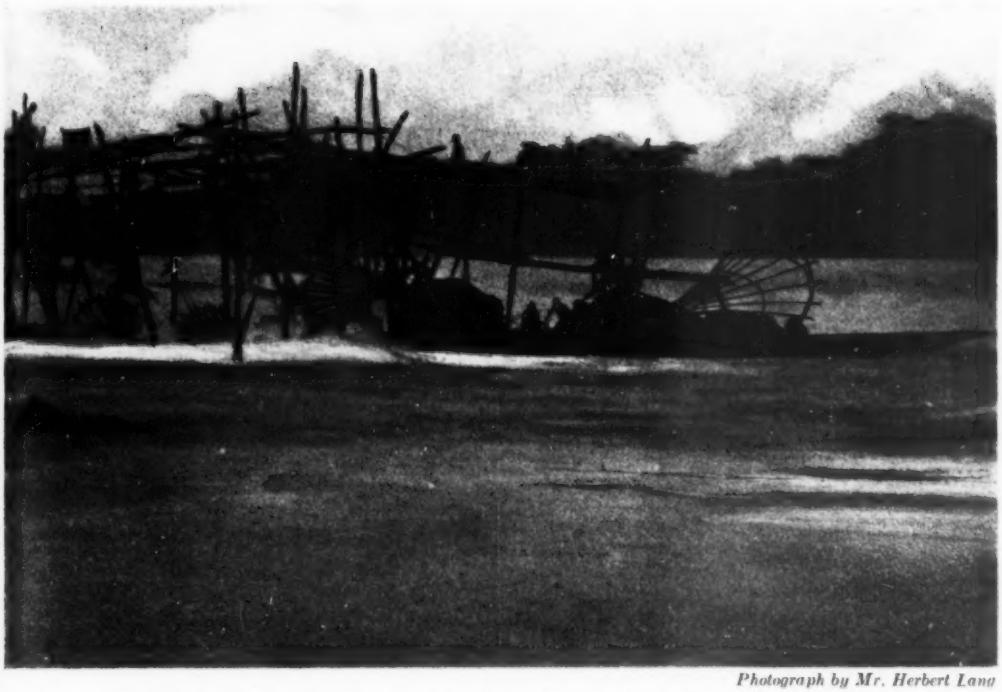
THE BLUE SHARK GROUP

This species, a frequenter of the open ocean, is bluer than those species commonly found near shore; it attains a length of 10 feet. Like most sharks it brings forth its young alive instead of laying eggs. In the group a brood of young fish is represented accompanying the mother as she swims about under gulf weed and other drift that accumulate out in the Atlantic, in the comparatively currentless Sargasso Sea. A thick water-soaked rope hanging from a floating spar adds variety and interest to the group and serves to direct attention, as the eye travels upward along it, to the character of the surface, otherwise easily overlooked. The group is the work of Mr. F. F. Horter and was made under the supervision of Dr. Bashford Dean

Stanley Falls of the Congo River, where the famous fisheries are located

very inadequate space for display. The new gallery will give ample scope for a great exhibition,—one which will compare with the exhibitions of fishes in London or Paris.

The new hall will be 138 feet long by 63 feet wide and 19 feet high, illuminated admirably on the long sides of the room by thirteen windows, each 9 feet wide by 8½ feet high. With this space at our disposal we plan an exhibition which will give the inquiring visitor a résumé of our knowledge of fishes from all points of view, aiming to be instructive, entertaining, and inspiring. It should appeal to the average museum visitor, in furnishing a picture of the wonder and beauty of fishes of many kinds, great and small; from the depths of the sea to the surface; of brooks, creeks, rivers, and torrents; of coral reefs and Gulf Stream; of rocky pools and sandy reaches. It will show fishes preying and preyed upon; mimicking and poisonous forms; the habits and instincts of fishes; their manifold types of breeding and development. These themes, carefully chosen, may be set forth in suitable habitat groups, arranged along the sides of a corridor that will pass down the middle of the great hall. This corridor, screened from the daylight by its ceilingward-reaching walls will depend for its lighting wholly upon the artificial illumination supplied by the groups, which will appear as great aquaria but picturing dramatic moments in the lives of fishes not ordinarily seen in the usual aquarium. Such types of groups we have already, in a measure, prepared. By such a procedure our fish gallery will be provided with two areas of exhibition: the central corridor, which has just been described, and the peripheral or surrounding gallery, which



Photograph by Mr. Herbert Lang

Here important collections were made by the American Museum Congo Expedition

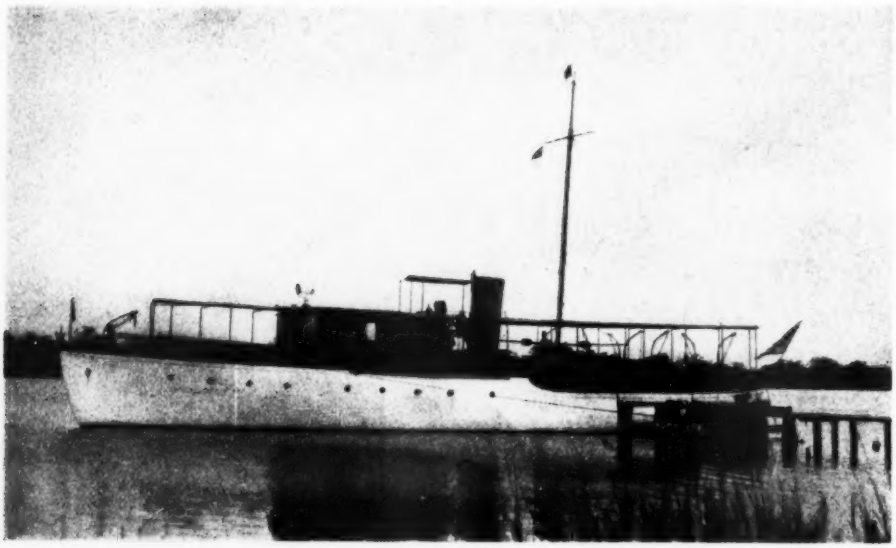
will provide space for exhibition approximating 320 feet in length and 13 feet in width, having on one side the great windows of the hall and on the other the wall of the central gallery. This wall will be an admirable place for the installation of cases, for it will be brilliantly lighted by the windows opposite to it. Along this space will be introduced a number of cases dealing with the natural history of fishes, and here we plan to arrange a series of exhibits to show:

(1) The fishes arranged according to their natural classification and importance.
(2) The structure and physiology of fishes.
(3) History of fishes, showing the fossil forms and leading up to the existing types.
(4) The development of fishes.
(5) The maladies of fishes.
(6) The game and commercial fishes of the world.
(7) The means of capture of fishes.
(8) The commercial products of fishes.

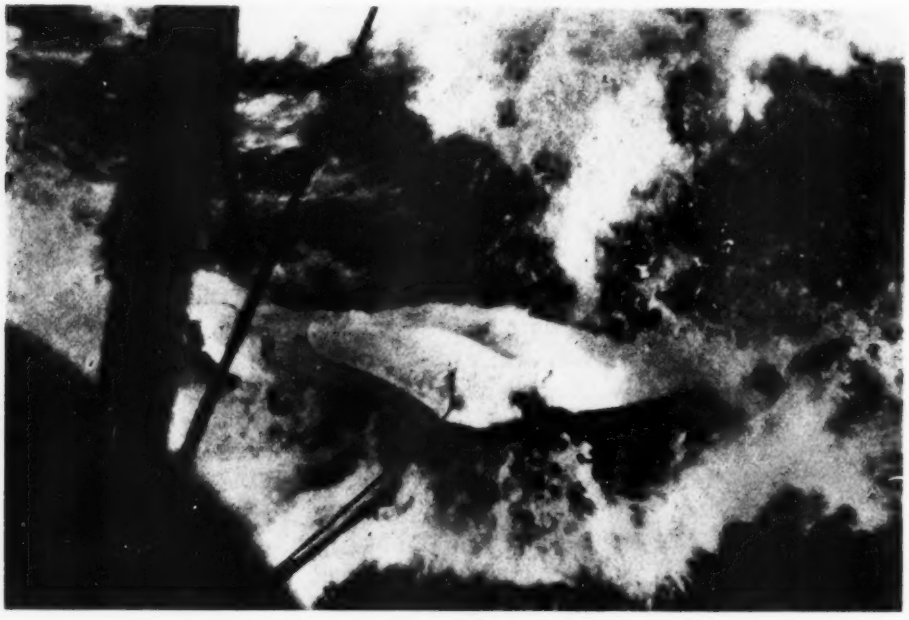
Throughout the entire hall the effort will be made to divide up the themes for exhibition on a *pro rata* basis, so that he who visits it may, even after a short stay, carry away with him more than a general idea of the system of fishes. The outer gallery will appeal to the student, the statistician, the angler, the merchant; the inner "aquarium" will surely be an inspiration to those visitors who are old-fashioned enough to be fond of natural history.

STUDY COLLECTIONS

The study collections of the department have increased notably during the past thirteen years. Three times as much material is now at hand as was available in 1910, and our catalogue includes 8000 cards. The bulk of our accessions are fishes from the West Indian fauna obtained in Florida by the Fabbri "Tekla" Expedition (1910),



The yacht "Tekla," in which Mr. Alessandro Fabbri, accompanied by his brother, Mr. Ernesto Fabbri, and Mr. John T. Nichols, of the American Museum, cruised the Florida Keys in 1910, obtaining extensive collections of characteristically West Indian fishes for the Museum



A devilfish, or *Manta*, being towed behind the "Tekla"

fishes from the west coast of Mexico by the "Albatross" Expedition (1911), under the leadership of Dr. Charles H. Townsend, and from the fresh waters of equatorial Africa by the American Museum Congo Expedition (1915). Additions of lesser importance have been made from the Arctic, the north and

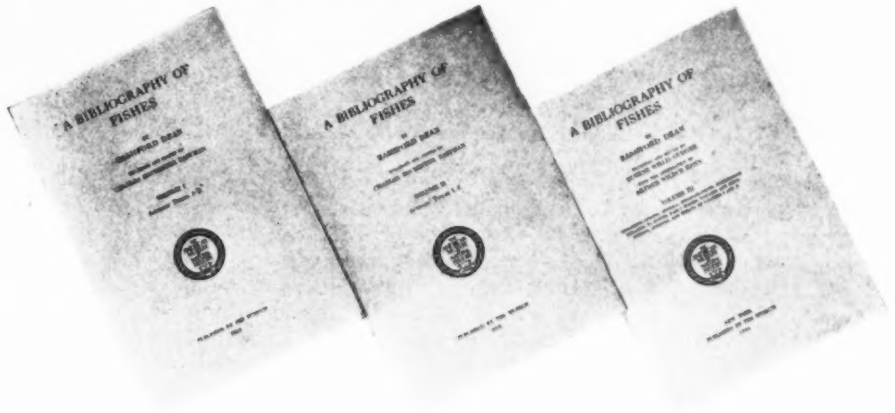
south Atlantic, the Mediterranean, the eastern, central, and western Pacific, the East Indies, and the fresh waters of North America, South America, and Asia. There have been no acquisitions from the Red Sea or Indian Ocean, our greatest faunal hiatus.

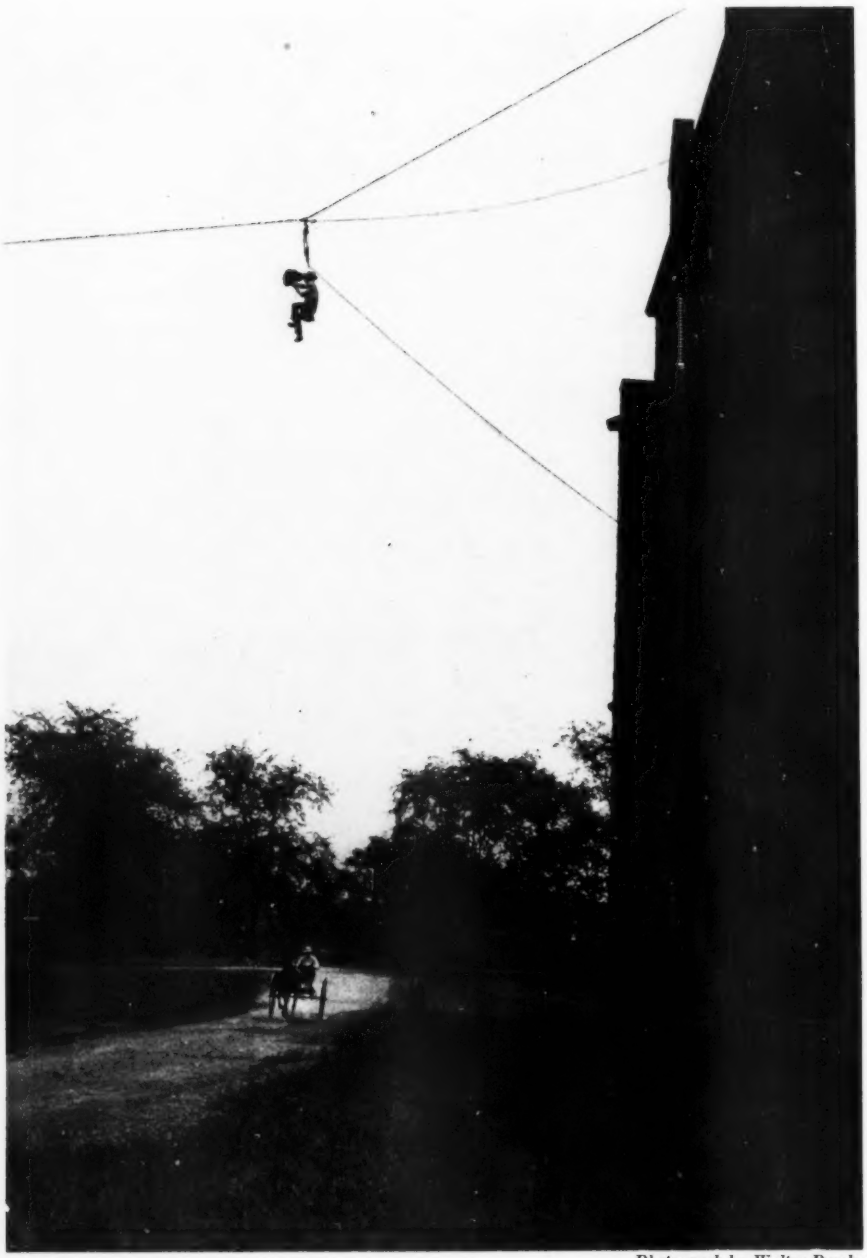
The study collection exhibiting the anatomy of fishes has also increased notably. Several scores of fish skeletons have been prepared and indexed for class use. They are, in fact, under constant requisition, especially for certain courses in the post-graduate department of Columbia University that are given in the Museum by Prof. W. K. Gregory. The laboratory work of the department has yielded not a few discoveries. These appear in several *Memoirs* of the American Museum, which deal with fossil as well as with living fishes; also in a number of smaller tracts, which report the results of our expeditions and describe 70 odd species and 6 genera new to science among recent forms, and in the case of fossils about 40 species and 10 genera.

BIBLIOGRAPHY OF FISHES

Our most important work, the one which we hope will ever remain as a landmark in ichthyology, is the *Bibliography of Fishes.*

Students of fishes everywhere have long needed a comprehensive catalogue of the vast literature in their field. To meet this need, the department has from the beginning aimed to complete and publish a comprehensive bibliography, which should include an index by the aid of which a searcher would have at his finger tips in minimum time all the information that exists concerning fishes of every kind, living and extinct, of all parts of the world, whether this information be published in English or in any other language. The first two volumes of this bibliography appeared respectively in 1916 and 1917, and jointly contained about 50,000 references arranged under "Authors." A third volume completing the work and including an elaborate subject index of more than 350 pages is now in readiness. Its compilers aimed to digest the subject matter of ichthyology in such a way that it would be available not only to technical students of the fishes, but to popular inquirers as well; also to the student of diseases, of parasites, of general physiology; to the archæologist, the historian, the chemist, the teratologist, the embryologist,—in a word, to anyone whose inquiries are concerned directly or indirectly with any subject related to the great group of fishes.





Photograph by Walter Beasley

PHOTOGRAPHING A SPEEDING RACE HORSE

No difficulty seemed too great for Mr. Chubb to overcome when he was making studies preparatory to mounting the skeleton of "Sysonby," the famous race horse now on exhibition at the American Museum. From a seat suspended fifty feet above the ground, Mr. Chubb took photographs of a race horse speeding below, that he might have accurate records of the motion of the spine and muscles in action. The studies were so successful that the same method was used later when the skeleton of the trotter "Lee Axworthy" was presented to the Museum

Mounting Horse Skeletons to Exemplify Different Gaits and Actions

A GLIMPSE BEHIND THE SCENES AT THE AMERICAN MUSEUM

By A. KATHERINE BERGER
Assistant Editor of NATURAL HISTORY

NOT so very long ago the osteological exhibition in a museum was merely a collection of sets of bones carelessly put together. No attention was paid to scientific mounting of the skeleton nor was any attempt made to express the living animal in action. As a result these exhibits defeated the very purpose for which they existed. They offered no incentive to the student or to the public even to visit, much less to study and make comparisons between, the different types of animals represented.

For instance, to convey to the spectator, through the mounted skeleton of a horse, some idea of the nicety of adjustment of every bone, and the positions assumed by it in relation to other bones during pulling, racing, trotting, and walking, is no easy task, and before accurate results are achieved, an amount of study, patience, and care is required little dreamed of by the casual observer.

For more than twenty years Mr. S. H. Chubb, of the department of comparative anatomy in the American Museum, has devoted all his attention to revolutionizing osteological preparation of Museum specimens. In the Museum collections is a nearly completed series of mounted skeletons of the Equidæ in which Mr. Chubb is striving to represent with scientific accuracy and in life-like pose every possible type of horse. There is a giant draft horse and, from practically the same stock, although representing another breed, the Shetland pony. The big horse has been developed through many generations for extreme size, whereas the Shetland pony has been reduced in size by man's selection and breeding. A heavy type of horse is shown in the position assumed when drawing a load. In contrast, there is the remarkable horse "Sysonby," known as one of America's most famous race horses, beautifully mounted to show the running gait char-

Photograph by Walter Beasley

A closer view of Mr. Chubb in the swinging seat, the lens of his camera pointed downward in readiness to photograph the horse in action

Photograph by S. H. Chubb

Bird's-eye view of a trotting horse in action.—The white line on the back shows the curving movement of the spine, while marks on the hips indicate the shifting angle of the pelvis with each step in the progressive movement

acteristic of his kind. The pure-blood graceful Arabian, believed to be descended from an entirely distinct wild species, is represented in the skeleton of "Nimr"; and now the skeleton of "Lee Axworthy," the champion trotting stallion of the world (his record being 1.58¼) is to be added, practically completing the series of domestic horses. There are only two wild types on exhibition. One of these is a wild ass, or kiang, known as the north Asiatic wild ass, a different species from the African ass from which our domestic ass is descended. The other wild type is the Grant zebra. This series will not be complete until all species of zebras and asses are on exhibition.

"Lee Axworthy," raised on the Walnut Hall Farm in Kentucky, was owned by the Pastime Stable, a concern consisting of four or five men, and was stabled at Castleton Farm, Lexington, Kentucky. The American Museum is largely indebted to Mr. D. M. Look, of New York, owner of Castleton Farm, for the skeleton of this famous trotter.[1] Mr. Chubb is finding the mounting of the skeleton of "Lee Axworthy" a most interesting study, as it gives opportunity to compare the bones brought into action in the fast trot with those employed in the more natural running gait of the race horse "Sysonby."

A slight idea of the painstaking care with which every contributing detail is studied and worked upon until scientific accuracy is attained, may be gained from some of the activities in connection with the preparation and mounting of the skeleton of "Sysonby." To represent properly the changing curves of the spine of the race horse when he is running his fastest, Mr. Chubb conceived the idea of making photographic studies of a race horse's back in action. Accordingly an arrangement of ropes was prepared and

[1]It is to the late Watson B. Dickerman that the American Museum is indebted for funds to mount the skeleton of "Lee Axworthy" and for opportunities to study trotting horses in action. See NATURAL HISTORY, July-August, 1923, page 423.

fastened at one end to the roof of the American Museum and at the other to an adjacent tree. A swinging seat suspended from the rope and steadied by guy ropes afforded an unobstructed vantage point for the accommodation of Mr. Chubb and his camera. A race horse was borrowed for the occasion. Certain points of the animal's anatomy, previously determined upon by Mr. Chubb as best marking the constantly changing curves of the spine and the shifting of the muscles in action, were outlined with white patches which would be clearly visible in the photograph. Even the shadow of the horse cast by the sun at right angles was taken into consideration to help portray in profile the position of the horse's feet and body at the moment of exposure. All being ready, Mr. Chubb was hoisted fifty feet above the ground, and the horse was raced back and forth below him while he took photographic studies of the horse's back.

This new and unusual method of photography, also used in the case of the "Lee Axworthy" skeleton, resulted in a series of studies which proved of great value in establishing accuracy of bone adjustment when the skeleton of "Sysonby" was ready for mounting. These studies were supplemented by frequent visits to race courses where many observations were made of horses in action.

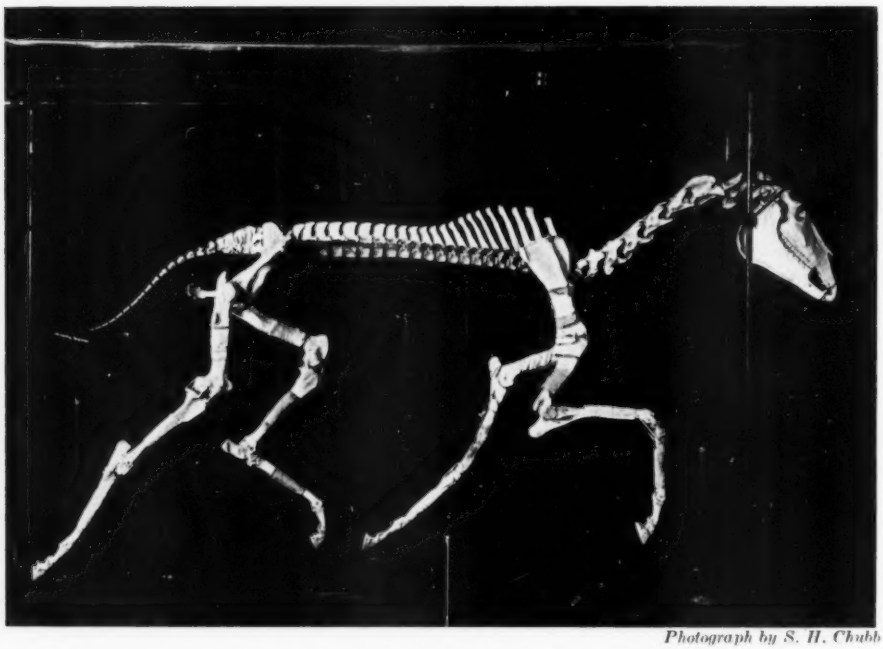
There is much to be done from the moment the skeleton is dissected to the time the bones are finally mounted. Sometimes these tasks are very time-consuming; eleven months were required to prepare the skeleton of "Sysonby" for exhibition.

The writer had an opportunity to witness a part of the preparation of the skeleton of the trotter "Lee Axworthy," listening the while as Mr. Chubb explained the process in progress at the time. Mr. Chubb was seated at a long table busily engaged in scraping from the sternum of the skeleton fragments of flesh and soft tissue that still adhered to the bone. Near him on the floor were several jars containing water in which were immersed various parts of the skeleton.

"I save the sternum or breastbone for the last," he said, "because it requires more time. The bones are connected with ligaments and tendons which must be removed before the actual cleaning and drying can proceed. To hasten the decomposition of the soft tissues, the bones are placed in vessels containing water that is kept at 100 degrees.

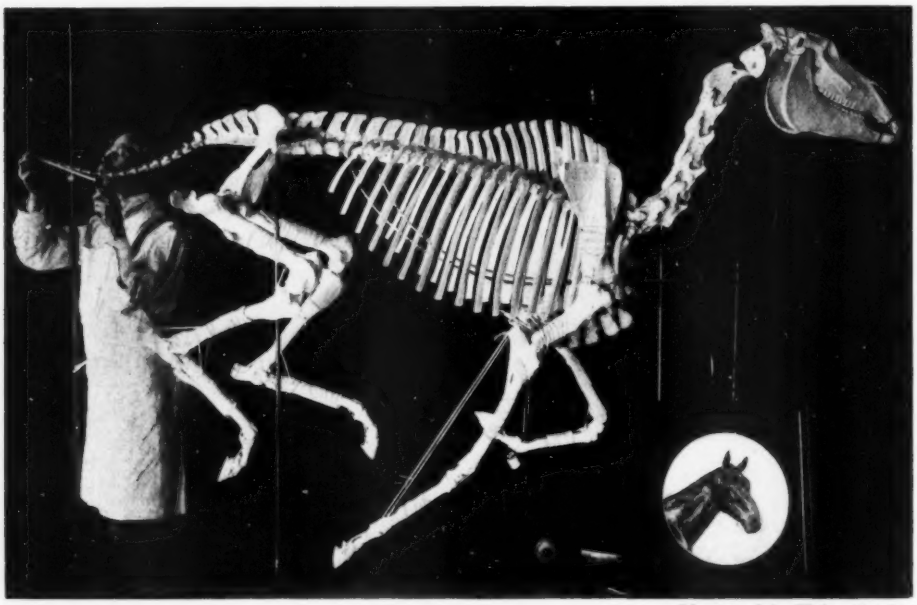
"When sufficiently decomposed the ligaments and tissues are removed and all that remains after dissecting is scraped away as clean as possible. If the surface of the bone dries too rapidly, it contracts and splits, while the inside is still wet. Slow drying is preferable and will prevent such injury by permitting the entire substance to dry evenly. The next step is to free the bones completely from all grease, that they may become spotlessly clean and pure in color before they are articulated."

Immersing the bones in benzine and exposing them while in this medium to daylight and sunshine for a number of weeks will accomplish the desired result most successfully. Under Mr. Chubb's supervision tanks have been constructed of galvanized iron. Around the upper edge of each tank are special grooves into which slides a close-fitting cover of glass, effectually sealing the tank against the entrance of rain water and at the same time preventing evaporation of the benzine. The bones are put in the tanks and covered with



Photograph by S. H. Chubb

The trotting horse, "Lee Axworthy," in the first stages of reconstruction.—In this stage every detail is subject to more or less modification, until the adjustment carries out the action Mr. Chubb has in mind to portray. Note the position of the bones in the fast trot as compared with the running gait of the race horse below



Photograph by Walter Beasley

The reconstruction of the "Sysonby," skeleton nearing completion.—When the bones are finally in satisfactory position and securely fastened, the threads, screws, suspending cords, and other temporary accessories are removed

benzine, the glass covers are moved into place, and the tanks are then carried to the roof of the Museum, there to remain in the sunshine until the bones are pronounced ready for the next step. The benzine must be changed two, three, or possibly four times during this period, because it becomes saturated with the grease and loses its efficacy, and the bones easily get discolored, gummy, and dirty if left too long in the greasy benzine. The whole process may take from six to eight weeks, depending upon the amount of sunshine and the size of the bones.

"After the benzine process," said Mr. Chubb, "the bones are ready for mounting. First, I get a steel rod as nearly as possible fitting the opening and extending the length of the neural canal of the spinal column. This rod I must shape to the curve of the spine. Then the vertebræ are hung tentatively in place. Next, I gradually study the bones of the legs, which I fasten together temporarily so that any change can easily be made in the angle of the joints. The legs are suspended by looped cords passed over the heads of small screws, which are inserted in the bones at various points. The other ends of these cords are passed several times over horizontal rods above. To these free ends are attached small weights sufficiently heavy to prevent slipping, thus affording easy and convenient adjustment. Now comes the delicate task of getting the bones into the position which seems to suggest the action I have in mind, and seems to do it in a perfectly alive and satisfactory way. Getting the ribs in position is a long operation. I take a very small piece of pliable steel rod and fasten to it the several ribs, each by means of a rubber band. Then I study the little articulations. Finally, when they are all satisfactorily placed, I devise a permanent brace to fit the ribs and hold them enduringly in place. Every step, meanwhile, is checked up and corroborated by constant comparison with a great number of photographs.

"As I get the adjustment nearer and nearer perfection, I see errors in this part or that which were not obvious when the bones as a whole were out of position. It is simply a process of eliminating the errors until the whole becomes perfect. When all is right, I drill small holes where the bones come in contact with each other, and into these holes drive steel wires just tight enough to hold firmly but not tight enough to break the bone. Where there are many little bones, wires are driven in from opposite directions to bind all together as firmly as possible. These wires are driven down just a little below the surface of the bone, and the small holes which result from this operation are filled up later with plaster."

In studying the trotting modifications found in the skeleton of "Lee Axworthy" Mr. Chubb remarked that these might possibly be found in a race horse, but they were not evident in the skeleton of the race horse "Sysonby." On the front pastern (but not in the hind) of the skeleton of "Lee Axworthy" was a slight depression in the bone due to extreme movement of the pastern joint in the trotting action. Said Mr. Chubb, "I can imagine that this might become adaptive and prove of great advantage in that particular action, but we cannot say that it has gone far enough at present to be of great consequence."

NOTES

ASIA

PRESIDENT OSBORN'S TRIP TO ASIA.—President Henry Fairfield Osborn, accompanied by Mrs. Osborn, sailed August 18 from Seattle on the S.S. "Madison" bound for Shanghai. As this issue goes to press, he is homeward bound to assume his administrative duties and scholarly researches at the American Museum. While in Asia he took a prominent part in the activities of the Third Asiatic Expedition. He made a trip to the Gobi Desert to supervise the work in progress there, and had an opportunity to examine the fossil beds and to further the success of the expedition by placing at its disposal his extensive experience as an organizer and his thorough grasp of palæontological problems. It was during his sojourn in the East that the Museum received word of the astoundingly large total of dinosaur skulls and skeletons obtained by the expedition and of the discovery of the dinosaur eggs.[1]

President Osborn narrowly escaped the earthquake in Japan by leaving Yokohama August 30 for Kobe. He did not learn of the disaster until the ship on which Mrs. Osborn and he were sailing was emerging from the Japan Sea, for only then was communication restored.

Prof. T. D. A. Cockerell, an honorary fellow of the American Museum, on the other hand, viewed the catastrophe from the harbor of Yokohama. He writes:

"We had about five days in Yokohama, and were on the 'Empress of Australia,' just about to sail, when the earthquake occurred. It was terrific, and with a strong wind blowing, soon all Yokohama was ablaze. The town was *utterly* destroyed. The loss of life must have been very great. We especially regretted the death of Mr. Jenks, U. S. Vice Consul, one of the finest men and ablest officials we had ever met. We soon had the ship filled with refugees, and they were coming on all night and the next day. On September 2, the ship and all of its passengers and crew came near burning up, as a great tank of oil in front of the Standard Oil building got afire, and the oil came drifting toward the ship at a great rate. The steamer was disabled and moved off with difficulty, but she was slowly turned round and out of the way. For about twenty minutes the matter was in doubt, and we saw the oil just where we had been shortly before. The next day we were hastily transferred to the 'President Jefferson.'"

FROM MOULMAIN TO BANGKOK.—Mr. Arthur Vernay, joint leader of the Faunthorpe-Vernay Indian Expedition of 1923, sailed from New York early in October to penetrate another zoölogical area of Asia in the interests of the American Museum. He and his associates will start from Moulmain, made famous by Kipling, for Karkareik, where elephant transport for the jungle will be secured. From there four months will probably be consumed in travel before the party, which will scour the intervening country, strikes the Meping River and secures boats for the trip to Bangkok, its objective. The territory to be penetrated is a ragged, steeply mountainous one, where there are no human habitations and where the members of the expedition will have to depend on their own efforts to supply their wants. Mr. Vernay will be accompanied in his exploit by two British Army officers—Col. E. Percy-Smith, who will devote himself to the smaller mammals, and Major C. H. Stockley, D.S.O., who with Mr. Vernay will engage in the collecting of the larger game. The expedition is fortunate also in having as one of its members Mr. Willoughby Lowe of the British Museum, who will give especial attention to the birds of the region.

The particular quest of Mr. Vernay in the area of Siam that will be traversed is the Schomberg deer. Antlers of this animal have from time to time been brought out of the interior by native hunters, but little is known regarding it. It has been assumed that the region harbors also a tortoise of vast size. What has been alleged to be the track of one of these reptiles has been seen, but the creature itself, if it exists, has up to the present eluded observation. Perhaps it will be the good fortune of the expedition to bring back definite word regarding it.

The unusual success that attended the recent expedition of Mr. Vernay and Colonel Faunthorpe augurs well for the outcome of the new undertaking. During the months that were devoted to hunting in India and Burma 129 specimens of mammals, representing 42 species, and 250 birds, representing 125 species, were obtained, not to mention

[1]See NATURAL HISTORY, September-October p. 536.

reptiles and other forms of life. The expedition received the most generous assistance from the Viceroy of India, Lord Reading, from Sir Harcourt Butler, Governor of Burma, and from the native princes and officials in the several areas visited. In the present expedition the King of Siam, as well as the Governor of Burma, is taking a cordial interest

MAMMALS

THE MUSEUM'S EXPEDITION TO ECUADOR. That the regions of Ecuador selected for investigation by Mr. H. E. Anthony, associate curator of mammals of the Western Hemisphere, American Museum, are yielding interesting specimens in abundance is evidenced by a statement in a recent letter from Mr. Anthony to the effect that he and his associate in the expedition, Mr. G. H. H. Tate, have been obtaining mammals at the rate of more than four hundred per month. The comparatively rare *Cænolestes*, a genus of marsupials the nearest relatives of which dwell in Australia, is always prized by collectors in Ecuador and Colombia. Mr. Anthony has succeeded in obtaining an unusually large series of this animal. On three different nights specimens were obtained of the rare fish-eating rats, and three weasels were part of the bag of a single day. Deer and wolves were among the larger game taken. Finally—an augury perhaps of similar achievements still in store—the collecting of a single morning totaled fifty-seven mamma'ls.

NEW GENERA AMONG THE CONGO MAMMALS.—Among the mammals new to science discovered by the Congo Expedition, under the leadership of Mr. Herbert Lang and Dr. James P. Chapin, are two of exceptional interest. They belong to groups currently considered as well known,—that is the African genets and the African monkeys. It is to be expected that new species will be found among the material from any region not previously represented in the collections of scientific institutions; but forms so distinct as to require generic differentiation are scarce among the larger mammals.

The unique fishing genet, *Osbornictis piscivora*, named by Dr. J. A. Allen in honor of President Henry Fairfield Osborn of the American Museum, was discovered by Mr. Lang along one of the numerous shallow streams which meander through the rain forest of the northeastern Belgian Congo. This genet is the size of a large cat and has a chestnut-brown fur, and a dark, bushy tail. That one of the civets should take exclusively to fishing for its livelihood is surprising, as they generally show the feline abhorrence of water. Externally the chief adaptation to this particular pursuit is the bare lower surface of the feet. But the sharp, arrow-shaped premolars and other peculiarities of the dentition indicate that the animal is well able to dispatch such elusive and slippery prey as small catfish and mormyrids.

The other discovery—that of a primate—is of especial interest. The specimen constitutes a new genus and has been described recently by Mr. Lang as *Allenopithecus* in honor of the late Dr. J. A. Allen. In size it resembles the famous Gibraltar monkey, so named because individuals of this species live along the rocks of the impregnable citadel. But although *Allenopithecus* resembles the Gibraltar monkey in general proportions, having a short, thick body and muscular limbs, it is not tailless. Of interest is the fact that it forms a link among the Lasiopygidæ between the more terrestrial baboons and the numerous arboreal guenons. This, the first monkey collected by the expedition, was shot by Doctor Chapin just before nightfall, when the steamer was made fast at the edge of the jungle along the Congo River near Bolobo, and was the first wild monkey he had ever seen alive,—a most auspicious beginning for a large expedition which was favored by luck throughout its six years of exploration in the Belgian Congo.

MR. GEORGE G. GOODWIN of the department of mammals, American Museum, spent the month of August and part of September in the Gaspé Peninsula of Quebec, hunting and trapping the smaller mammals, of which he obtained a total of 200 specimens, representing 22 species and including water shrews, pigmy shrews, mink, and other fur bearers. From Montreal to Ste. Anne des Monts he went by automobile, making camp two miles beyond the town on the banks of the Ste. Anne River. Thence he traveled as far as the rough ground would permit by wagon, but was finally compelled to transfer his equipment to a wheelless platform of boards, a raftlike conveyance that, drawn by the horse, managed to ride over the swells of ground and the wreckage of fallen trees that frequently barred the way. Later even this conveyance had to be discarded, and the journey to the base of Mt. Albert in the Shickshock Range

was made on foot. The region is a rough and rocky one, where the mountain trees—for the most part spruce and balsam—have poor roothold and are frequently torn from their anchorage by the strong wind. Swift mountain streams, that rush past the islanded bowlders that attempt to obstruct their course, are the haunt of the salmon, the bold leaps of which were a sight to be remembered.

A Rare Siberian Martin.—The American Museum has been fortunate in receiving as a gift from Mr. John B. Deane, of the Far Eastern Commercial Corporation, the skin of one of the rarest and most beautiful of martens (*Charronia flavigula borealis*). Although this form was discovered as long ago as 1862 by Gustav Radde in the Bureja Mountains of the Amur region of northeastern Siberia, few specimens have found their way to museums. Equal in size to an American fisher (*Martes pennanti*), it is classed among the largest of the martens, the tanned skin presented to the Museum measuring three feet, six inches from the tip of the nose to the end of the tail vertebræ. The longer, darker hair of the body has that distinctive metallic golden luster to which so many fur bearers owe their high rating in the pelt market. The deep yellow of the throat, broken up by snowy white, and flanked toward the upper parts of the neck by black, the exceedingly long bushy tail, and the dark limbs make the animal ornamental in the highest degree. As sometimes happens, shortly after this valuable skin was presented, the American Museum received another skin, of the closely related southern Indian form. This skin was acquired through the Faunthorpe-Vernay Indian Expedition, which has filled in so many gaps in the Museum's collections of Asiatic mammals.

OTHER MUSEUMS

The Expedition of the Field Museum to Chile and other parts of South America recently returned to Chicago after an absence of nine months. During the early stages of the expedition much attention was given to Chiloe and other islands off the coast. The northern half of Chiloe is quite thickly settled, but the southern half is wild, uninhabited, and from a zoölogist's standpoint very interesting. The weather favored the members of the expedition and they were able to coast in small boats to the most desirable points. About four hundred specimens of birds and mammals were obtained during the sojourn at Chiloe. Of the birds, many marine forms were collected by Mr. H. B. Conover, who accompanied the expedition at his own expense; among the mammals there were, in addition to those known to the natives, some they did not recognize.

Perhaps the most interesting mammal obtained at Chiloe was the tiny deer known as the *Pudu*, of which there are only a few specimens in American museums.[1] It is the smallest of the deer family, that is, of the true deer that shed their horns annually. The largest male obtained by the expedition weighed only twenty-four pounds and had horns just three inches long. It stands about seventeen inches high at the shoulder.

In addition to collecting five specimens of this deer in Chiloe the expedition secured the smallest of the South American foxes. Darwin noticed this species on his famous voyage but since then it has remained comparatively unknown. Even the natives of Chiloe doubted its existence and one well educated man on the island who had a copy of Darwin's volume on the voyage of the "Beagle" was rather inclined to insinuate that Darwin had told a fairy story about the fox. Happily Dr. W. H. Osgood, who headed the expedition, was able to vindicate Darwin by capturing a specimen in a trap which he set for the purpose.

Other mammals obtained were a marsupial related to *Cænolestes*, otters, spotted cat, a small series of the coypu (an aquatic rodent almost as large as a beaver), and mice.

Among the frogs and toads collected at Chiloe the most interesting species was *Rhinoderma darwinii*, the male of which carries the eggs and the little frogs, when they emerge, about with him in his vocal pouch, which stretches back into a lymph space between the abdominal muscles and the skin. Doctor Osgood gently squeezed a *Rhinoderma* that he had captured and the batrachian opened its mouth, showing it full of tiny little ones that had been forced upward through the pressure.

While the visit to the island of Chiloe had very notable results, the work of the party in several other localities proved equally interesting. While at Santiago, Doctor Osgood examined the collections of the Museo Nacional de Chile with especial reference to

[1] A specimen of the Chilean *Pudu* is in the American Museum, and specimens of the Ecuadorian *Pudu* are in that institution and in Philadelphia.

the types of mammals described by Doctor Philippi. He was able to make satisfactory identifications of most of these forms, the inadequate description of which has, heretofore, been a difficulty in the study of Chilean zoölogy. In pursuance of a general policy of establishing relations with the museums of southern South America, he called at the Argentine museums in La Plata and in Buenos Aires, and later visited the Brazilian museums in São Paulo and Rio de Janeiro.

The southernmost station in Chile reached by the expedition was the Rio Nireguao, latitude 45° 20′ South, a short distance north of Lake Buenos Aires. Doctor Osgood and Mr. Conover reached this point by crossing the Andes from the coast via the Rio Aysen. In this area, great herds of the guanaco are found on the pampas. The ostrich-like rhea is abundant. Most impressive of all are the vast numbers of waterfowl of all kinds in the lakes and marshes.

Mr. Conover is especially interested in the game birds of the world, his private collection being deposited in the Field Museum. The game birds secured by him, more than three hundred in number, form one of the most valuable and interesting parts of the collection made by the expedition.

Subsequently Doctor Osgood and Mr. Conover went to Buenos Aires. While in the Argentine Republic, Doctor Osgood made two short expeditions, one to the typical pampas country southwest of Buenos Aires, and one to the mountainous province of Jujuy, on the Bolivian border.

The Museum's work in Chile will be continued throughout the warm season of 1923–24, by Mr. C. C. Sanborn, assistant in the division of birds. During the Chilean winter, Mr. Sanborn collected in the northern part of that country.

REPTILES AND BATRACHIANS

Collecting Specimens for a Gila Monster Group.—Mr. Arthur I. Ortenburger, assistant curator of herpetology, American Museum, spent the summer in the neighborhood of Tucson, Arizona, collecting reptiles in the foothills of the near-by Santa Catalina Mountains. In this area it was hoped that there might be obtained material for a group of the Gila monster, the conspicuously marked lizard of our Southwest—the only venomous lizard in the world—and the fact that fifteen specimens were taken (of which eleven were shipped back alive) proves that the hope was well justified. Although incapable of fast locomotion—the fat drooping body being a rather cumbersome load for the short legs—the lizard is one to be approached with caution, for at close quarters it will lunge at its antagonist with the rapidity of a snake. Practically all of the specimens captured were encountered on the broad level shelves that form a kind of terrace on the sloping cañon sides.

By far the most prevalent snake in the area was the desert diamond rattlesnake, *Crotalus atrox*. Of this reptile more than forty specimens were taken, not to mention three specimens of the more uncommon species *Crotalus molossus*, and one specimen of the very rare *Crotalus tigris*. It is a common belief that the rattlesnake invariably sounds its warning upon the approach of a potential antagonist, yet of the forty-five rattlesnakes obtained by Mr. Ortenburger only two took the trouble to give notice of their presence and, even when definitely attacked with a discharge of dust shot to facilitate capture, not more than one in five would give a challenging dry buzz.

It is interesting to note that the black whip snake, *Masticophis piceus*, formerly assumed to be merely a melanistic phase of the western red racer, *Masticophis flagellum frenatus*, was actually more prevalent in the region than the latter.

The most important observations concerning habits were made on the spadefoot toad, represented in the area by two species, *Scaphiopus couchii*, and *S. hammondii*. It was noted that these amphibians—which derive their common name from the fact that they are armed on the underside of the hind foot with a horny projection, which is of aid in digging—spent their days ensconced in the dry soil, in which they burrow, but after nightfall would free themselves of their sandy covering and make their way with active leaps toward the puddles of stagnant rainwater. The male spadefoot bleats like a lamb, and it was this unwonted sound in a region comparatively deserted that first led to its detection.

In all, 1607 specimens were collected, including sixteen tortoises,—a reptile one does not think of as a dweller of the desert.

AUSTRALIA

Achievements of the Expedition of the American Museum.—The recent return of

Mr. H. C. Raven from Australia makes opportune a review of the work of the Museum's Australian expedition as a whole.

The expedition, consisting of Dr. William K. Gregory and Mr. Harry C. Raven, the latter in charge of field work, left New York in May, 1921. The first object was to open up relations of friendly coöperation with Australian museums and naturalists; the second was to secure a representative study collection of the Australian fauna, especially the mammals; the third and most important was to obtain material suitable for exhibition. The expedition has been very successful in the attainment of all of these objects.

While in Australia Doctor Gregory arranged a number of exchanges, which during the past two years have been largely consummated. The American Museum has sent to several Australian museums accurate replicas of the great skull of *Tyrannosaurus*, original limb bones of the huge *Brontosaurus*, model restorations of *Camarasaurus*, complete and beautifully executed models of two Indians of the Plains, a life-size replica of the skeleton of the great fossil amphibian, *Eryops*, a series of Professor McGregor's restorations of prehistoric men, and other material.

On their part the Australian museums have sent the American Museum a replica of the skeleton of the giant marsupial *Diprotodon*, an original skull of the so-called marsupial lion, *Thylacoleo*, original remains of *Diprotodon* and other extinct marsupials, an extensive series of casts of type specimens of extinct marsupials described by Owen, and some fine slabs containing fossil ganoid fishes of peculiar type. Models of Australian aboriginals with accessories for a group are also promised. The Australian naturalists have been more than generous in helping the Museum to fill the gaps in its collection of mammals, and have sent a number of very important and rare marsupials not hitherto represented. Of scarcely less value has been the exchange of scientific ideas and information and the promise of continued coöperation.

Mr. Raven's field work, which extended from August, 1921, to February, 1923, was highly successful in spite of the difficult conditions at present confronting foreign museum collectors in Australia. Through the liberal policy and active coöperation of the directors of several Australian museums and government officials he was enabled to secure permits to collect a limited and specified number of specimens in Queensland, New South Wales, and Tasmania. For such active and timely coöperation and assistance Mr. Raven is deeply indebted to the following gentlemen: Dr. Thomas Storey Dixson, president, Dr. Charles Anderson, director, Mr. Charles Hedley and the entire staff of the Australian Museum at Sydney; Prof. Launcelot Harrison, Sydney University; Dr. A. H. Burckitt, of the School of Medicine, of that institution; Mr. A. H. Chisholm, of the *Sydney Daily Telegraph;* Mr. Ellis S. Joseph, Sydney; Mr. Harry Burrell, Sydney. Mr. A. S. Le Souëf, Taronga Zoölogical Park; Mr. Heber Longman, director of the Queensland Museum and Mr. M. J. Colclough, of that institution; Mr. William Gray, North Queensland; Prof. F. Wood Jones, University of Adelaide; Mr. H. H. Scott, curator of the Victoria Museum and Art Gallery, Launceston; Dr. Ray McClinton, Launceston; Prof. T. T. Flynn, and Colonel Thomas, University of Tasmania; Mr. E. Burles, manager of the Arthur River Sawmill, Tasmania.

Mr. Raven will give some account of his experiences and of the highly interesting Australian mammals in a later issue of NATURAL HISTORY. But here it may be said in a word that as a result of his work the great majority of the genera of Australian mammals are now represented in the collections of the American Museum. This would convey no idea, however, of the excellent character of the material for study and exhibition brought back by Mr. Raven. Besides the beautifully prepared skins of mammals, he has an unusually complete series of skeletons and an even more valuable collection of anatomical preparations and entire animals preserved in alcohol. In addition to these he has a small but representative series of bird skins and a valuable collection of birds preserved for dissection. Considerable embryological material was also obtained, as well as photographs of living animals and notes on their habits.

Plans for exhibits in the proposed Australian section have been adopted and the work of the preparators is well under way. A temporary exhibit of some of the material secured by the expedition has been installed in the hall of woods and forestry.

DR. E. O. HOVEY'S TRAVELS AND OBSERVATIONS.—In a letter written under date of September 4 from West Maitland in New South Wales, Dr. E. O. Hovey, the representa-

tive of the American Museum at the Second Pan Pacific Scientific Congress, held in Sydney and Melbourne, speaks appreciatively of the work done by the Congress and of the hospitality shown the visiting delegates by their colleagues in Australia. Not a few of the American Museum's major undertakings in recent years have been devoted to the Pacific and regions contiguous to it, and Doctor Hovey was privileged to present to the gathering accounts prepared by Professor Osborn and Dr. W. D. Matthew, regarding the Third Asiatic Expedition and a statement by Dr. Robert C. Murphy concerning the Whitney South Sea Expedition. Doctor Hovey also delivered a paper, which he wrote by request, on the rocks of the volcanic Caribbees, and finally he presented an abstract of an article by Dr. Chester Reeds on varve clays and other seasonal records of geologic time, a subject elucidated by Doctor Reeds in the July-August issue of NATURAL HISTORY.

In addition to attending the Congress and paying visits, under the friendly guidance of Australian men of science, to the local museums and universities, Doctor Hovey has been able to inspect in their company certain geologic sites of interest. Near Adelaide he viewed the Pre-Cambrian (or Cambrian) and the Permocarboniferous glacial deposits. He spent three days in the famous mining district of Broken Hill, entering three of the great mines. On his way from Broken Hill to Sydney he stopped to visit the Jenolan caves, famous for their beauty of dripstone formation and the magnificance of their chambers. The great copper mine at Mt. Lyell on the west coast of Tasmania was another objective.

Among the excursions of special promise to which Doctor Hovey alluded in his letter was one contemplated to the Great Barrier Reef. Doctor Hovey expressed the hope that this trip, made possible through the generous action of the government of Queensland, would enable him to secure corals from the reef as well as other forms of marine life of interest to the American Museum.

Among those to whom Doctor Hovey is under special obligations for friendly helpfulness and hospitality are Prof. E. W. Skeats, Sir Douglas Mawson, Dr. L. K. Ward, Prof. R. L. Jack, Mr. Charles Hedley, and the Governor of Queensland. But indeed the list would have to be greatly extended to give recognition to all of those who in one way or another enhanced the interest or contributed to the value of Doctor Hovey's trip.

BIRDS

THE FORTY-FIRST STATED MEETING OF THE AMERICAN ORNITHOLOGISTS' UNION was held at the Museum of Comparative Zoölogy, Cambridge, October 9–11. Forty-three papers were presented before the gathering, and of these twelve were contributed by the members of the scientific staff of the American Museum. Dr. Frank M. Chapman presented the first paper of the opening session, entitled "The Arrangement of a Study Collection of Birds." A paper on "Midsummer Song Sparrows," prepared jointly by Mr. John T. Nichols and Mr. Rudyerd Boulton on the basis of a statistical study of banding data, was contributed to the Bird Banding Session on October 10.

Five of the six papers that made up the program of the Technical Session were of Museum authorship. In their order of presentation they were: "The Forms and Representatives of *Calonectris kuhli*" by Dr. R. C. Murphy, "Remarks on *Thraupis sayaca* and Its Allies" by Mrs. Elsie M. B. Naumburg, "Life Zone Problems of the New York City Region" by Mr. Ludlow Griscom, "Remarks on the Classification of Birds," by Mr. W. DeW. Miller, "Criteria for the Determination of Subspecies in Systematic Ornithology" by Dr. Frank M. Chapman.

On the afternoon of October 10, Dr. James P. Chapin presented a paper on "Birds of the Kasai District, Belgian Congo," followed in close succession by a "Report on the Progress of the Whitney South Sea Expedition" delivered by Dr. R. C. Murphy.

The closing day of the meeting was signalized by several interesting papers, among them being three from members of the American Museum: "Notes on American Oyster Catchers" by Dr. R. C. Murphy, "Notes on the Summer Birds of Newfoundland" by Ludlow Griscom, "Mutation *vs.* Evolution by Environment in Birds" by Dr. F. M. Chapman.

Dr. Jonathan Dwight, research associate in North American ornithology in the American Museum, was elected president of the Union, and Dr. Joseph Grinnell, of the University of California, and Dr. Alexander Wetmore, of the Biological Survey at Washington, were elected respectively first and second vice presidents. Dr. T. S. Palmer and Mr. W.

L. McAtee were re-elected respectively secretary and treasurer.

VERTEBRATE FOSSILS

FOSSILS FROM THE SIWALIK HILLS OF INDIA.—The collections made, through the generous gifts of Mrs. Henry C. Frick, in 1922 by Mr. Barnum Brown, associate curator of fossil reptiles, American Museum, in the Tertiary formations of the Siwalik Hills of India are now being unpacked and catalogued for study. They include a splendid series of skulls of fossil elephants and mastodons, rhinoceroses, hippopotami, giraffes, antelopes, deer, three-toed horses, and other animals of this magnificent extinct fauna, first discovered ninety years ago and described by Falconer, Cantley, and other English writers. Among the most interesting specimens are three jaws of anthropoid apes, whose exact relations to their modern descendants, or possibly to man, will be a subject for careful and painstaking study. Fossil specimens of the higher anthropoids are exceedingly rare finds in the Tertiary formations, and are of extraordinary interest because they are the nearest known relatives of man existing that far back in geologic time. We may yet discover among them species that we can regard as his direct ancestors. Plaster casts of nearly all the known specimens of these Tertiary anthropoids have been secured by the Museum, but these are the first original specimens to figure in an American collection if one excepts the fossil tooth from Nebraska described as *Hesperopithecus*.

FIELD WORK IN WESTERN NEBRASKA.—A fossil-hunting expedition from the American Museum, in charge of Mr. Albert Thomson, has been operating in western Nebraska during the summer. The expedition has now completed its work and eleven cases of fossils have arrived at the Museum. Most of the work was in and around the Snake Creek Fossil Quarries, where a very interesting ape tooth, the only one known from the New World, was discovered recently. Mr. Thomson reports that the expedition could not find any more ape teeth, but secured a large series of skulls and jaws of three-toed horses, camels, deer, and other extinct animals. The best specimen, he states, is the skull and jaws of a gigantic camel, much larger than the modern Bactrian camel. This is the sixth year that the Museum has worked these quarries, which have yielded many thousands of skulls, jaws, teeth, and bones, belonging to more than 110 different species of animals.

ANTHROPOLOGY

THE CREATION STORY AMONG THE NAVAJO.—By means of a fund given for the purpose by Mrs. Dorothy Straight, Dr. P. E. Goddard, curator of ethnology, American Museum, made a field trip to the Navajo Indians during the latter part of August and the first three weeks of September. The Navajo are by far the largest American tribe of full-blooded Indians, numbering about 30,000. To a remarkable degree the changes in their mode of living since the coming of the Spaniards in 1540 have been spontaneous. Comparatively few Navajo have as yet come under the direct influence of missionaries or schools. Taking over sheep, they became pastoral but did not entirely give up their pre-Spanish agriculture. From the wool of the sheep they developed blanket weaving originating many designs. The growth and spread of culture as the result of such new contacts is the prime interest of ethnology.

The Navajo, perhaps in part because of their numbers, have a most interesting unwritten literature. Much of this is already known through Dr. Washington Matthew's *Navajo Legends*. There are among the Navajo many schools of "priests," or singers, to use the native term. Each school seems to have a special narrative of events regarding the beginning of things, starting with a lower first world inhabited chiefly by insects. As the narrative unfolds, an explanation is given of the origin of the ceremony conducted by these priests. There exist, therefore, among the Navajo numerous versions of the origin of the world which are in many particulars inconsistent.

During the field trip Doctor Goddard was able to secure from Indian informants a good deal of the creation story which he recorded in Navajo text. This assures its preservation in a more accurate form than is possible in a translation. The Franciscan Fathers of St. Michael's have issued an excellent dictionary of the Navajo language but no texts except songs have been printed.

Dr. Gladys A. Reichard of Barnard College took part in the trip under the auspices of the Southwest Society, paying especial attention to the social and family life of the Navajo.

It is planned to continue the work next summer with the same Indian informants,

one of whom is a man of much influence. He is interested in the recording of his accounts of the origin and growth of the Navajo tribe, so that his grandchildren may read them rather than learn them orally.

Biological Laboratory at Cold Spring Harbor

The biological laboratory at Cold Spring Harbor is being taken over from the Brooklyn Institute of Art and Sciences by a corporation organized for the purpose. A board of managers, consisting of fifteen individuals, has been formed and among the biologists appointed to this board is Dr. G. Clyde Fisher of the American Museum. The laboratory was organized by Dr. Bashford Dean and directed by him during the first year of its existence. For a third of a century, during the summers, it has offered courses and has furnished opportunity and material for research in the biological sciences. Following Doctor Dean, Dr. H. W. Conn was director for a number of years, and Dr. Charles B. Davenport, who succeeded him, has been at the head of the institution for about a score of years. Coincident with the change in management Doctor Davenport has retired from the directorship, and one of the first acts of the new board was to nominate Mr. Reginald C. Harris to serve as director until the transfer to the new corporation is consummated.

ERRATA

Through an error in the pagination indicated in a footnote on page 507 of the September-October issue of Natural History inadequate credit was given, on the one hand, to Miss Mary Cynthia Dickerson for the series of pictures illustrative of her work in nature photography that found place in that issue and, on the other, to Doubleday, Page and Company for their courtesy in permitting the reproduction of these photographs. The pictures that accompanied the symposium of articles headed "Mary Cynthia Dickerson" were all, exclusive of the frontispiece, taken by Miss Dickerson.

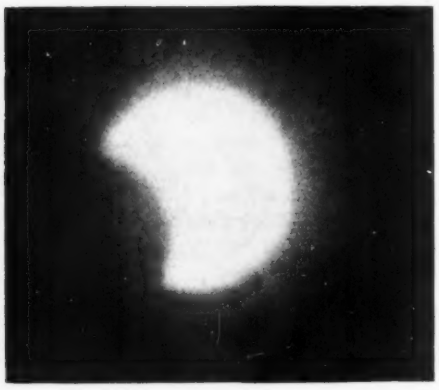
FISHES

The American Society of Ichthyologists and Herpetologists held its eighth annual meeting on October 12, at the Museum of Comparative Zoölogy, Cambridge, Massachusetts. Dr. G. K. Noble, associate curator of herpetology, American Museum, gave an illustrated lecture entitled "Observations on the Habits of Some Local and Exotic Amphibia." At the business session Mr. John T. Nichols, associate curator of recent fishes, American Museum, was elected president of the society for the ensuing year. In view of his multifarious responsibilities Mr. Nichols asked to be relieved of the editorship of *Copeia*, the magazine of the society, and accordingly Dr. E. R. Dunn was chosen editor in his stead. It is due almost entirely to the initiative of Mr. Nichols that *Copeia* came into being, and had it not been for his ability, energy, and devotion in maintaining its standard throughout the years of his connection with it—a connection which has been coextensive with its existence—it would have failed to take the rank it now holds among scientific publications.

A Monument to Alfred G. Mayor.—A fitting memorial in honor of Alfred G. Mayor (whose death on June 24, 1922, was reported in the July-August number of Natural History for that year, p. 380) has been erected on Loggerhead Key, Tortugas, Florida, between the old and new buildings of the Marine Biological Laboratory of the Carnegie Institution of Washington. The memorial was designed by Mrs. Mayor, well known for her work as a sculptor, and was paid for by contributions from those who had enjoyed the hospitality of the station when Doctor Mayor presided over it. The inscription on the tablet, which is of bronze, fastened to a shaft of concrete, reads as follows:

ALFRED · GOLDSBORO · MAYOR
WHO · STUDIED · THE · BIOLOGY · OF · MANY · SEAS · AND
HERE · FOUNDED · A · LABORATORY · FOR · RESEARCH
FOR · THE · CARNEGIE · INSTITUTION · DIRECTING · IT
FOR · XVIII · YEARS · WITH · CONSPICUOUS · SUCCESS
BRILLIANT · VERSATILE · COURAGEOUS · UTTERLY
FORGETFUL · OF · SELF · HE · WAS · THE · BELOVED · LEADER
OF · ALL · THOSE · WHO · WORKED · WITH · HIM · AND · WHO · ERECT
THIS · TO · HIS · MEMORY · BORN · MDCCCLXVIII
DIED · MCMXXII

Thanks to the devoted labors of Mr. John Mills, the chief engineer of the station, the monument is assured a permanence which nothing short of an earthquake can put in jeopardy. Mr. Mills dug through the coral sand that covers the surface of the Tortugas until he reached the oölitic limestone that forms the foundation of the island. Iron pipes were then driven as far into the rock as was possible and around these metal supports the concrete structure, only a portion of which shows above the surface, was reared. The monument is thus literally anchored to the bed rock.



NATURAL HISTORY is indebted to Mr. Frederick G. Kuhlkin for the privilege of reproducing this photograph of the final phase of the recent eclipse of the sun, which Mr. Kuhlkin took at Sheepshead Bay, Long Island, with a No. 3 kodak through an amber-colored screen that had been smoked with a match. The lens was an anastigmat 7.7 and the exposure was 1/25 of a second.

A CAPTURE OF A WHALE SHARK.—In the issue of *Science* for September 7, 1923, Dr. E. W. Gudger, associate in ichthyology, American Museum, gives an account of a whale shark, captured June 9, 1923, by Mr. Claude Nolan off the Florida Keys. Various hard parts of this shark, the fourth specimen of *Rhineodon* to be recorded from the Florida coast and the fifth from the Atlantic Ocean, were obtained for the American Museum. A sketch of the fish, made by Mr. L. L. Mowbray, accompanied by careful measurements and an exact description, will make possible the construction of a life-size model of the huge shark, which is more than thirty feet in length, for the new hall of fishes. Doctor Gudger has contributed also to the issue of *The Fishing Gazette* for August 18, 1923, an article entitled "Fish Smelling and Tasting of Iodoform—An Explanation."

INSECTS

THE BALTIMORE GROUP.—In the hall of insects, American Museum, there has recently been installed a group representing the life history and characteristic environment of the Baltimore butterfly, *Melitæa phaëton*. As one approaches the group from the right, one glimpses through a vista in the vegetation a representative marsh scene, with the iris lifting its purple tops, the skunk cabbage with unfolded leaves, and a frog alert and ready to leap. The setting has been flashed upon one's mind, but in the next instant, standing in front of the group, one's attention is absorbed by the insects themselves.

Like other butterflies the Baltimore has its three ages (or four if the egg stage be included) but they are more wonderful in their contrasts than are the seven ages of man. On a leaf is shown a yellow mass of newly laid eggs; on the under side of another leaf is a compact cluster of red. Few would at first thought connect the two, yet the red formation represents the matured eggs, from which the caterpillars are about to emerge. The caterpillars of this butterfly overwinter, and evidence of the winter shelter, or hibernaculum, in which the caterpillars shown in the group have spent the cold months, is afforded by a brown and shriveled cluster of dry leaves held together by silken strands of the insects' spinning. The spiny caterpillars themselves are shown in characteristic attitudes, either crawling over the leaves or pendent from them, ready to pupate. On some of the plants are the whitish chrysalids with their dark and orange markings, and from one of these a butterfly has just crawled and is resting with folded wings. On the broad leaf of a skunk cabbage another Baltimore is seen with its wings spread wide,—a position frequently assumed by this butterfly.

Within the space of a few square feet is thus presented the life cycle of this insect, which, although one of the lesser creatures of earth, presents many phases of interest to observing eyes. The group was prepared, under the supervision of Dr. Frank E. Lutz, from field studies made by Mr. F. E. Watson. The insects were mounted by Mr. Charles Wunder; the background was painted by Mr. Albert Operti. The representation of the habitat is due to the skill of various members of the department of preparation, especially Messrs. Coleman, Peters, and Rector.

LOWER INVERTEBRATES

THE UNDERWATER PAINTINGS OF ZARH H. PRITCHARD.—Through the generosity of friends of the American Museum the department of lower invertebrates has received a splendid gift, consisting of five paintings of undersea life by the noted submarine painter, Mr. Zarh H. Pritchard. These form the first installment of a series of twelve, the remainder of which, it is hoped, may be acquired in the future. These exquisite examples of Mr. Pritchard's work were painted by him from

sketches made on waterproof canvases and represent submerged vistas of living corals in the lagoons of Pacific islands, especially those of the Society Group. To secure them, Mr. Pritchard put on a diver's suit and descended into the unusually transparent waters of this region, producing pictures from a viewpoint hitherto known only to divers. He has depicted in oils the delicate hues of the living corals and the graceful arches and caverns which underlie the coral reefs, as they appear suffused with the iridescent light which penetrates the coral depths.

These paintings are now on temporary exhibition in the Darwin hall of the Museum. It is intended to give them a permanent place in the new hall of ocean life, which is now being erected. There they will form part of the setting for the great West Indian Coral Reef Group, which has been projected as one of the striking exhibits in this hall.

Two of the paintings were donated by Mr. Arthur Curtiss James, one by Mrs. William K. Vanderbilt, one by Mr. Paul M. Warburg and Miss Bettina Warburg, and one in memory of Mr. John Wood Stewart, who with Mr. Pritchard went down into the beautiful depths of the coral reefs of Pagopago in January, 1917. Mr. Pritchard's work has been exhibited many times, both at home and abroad, while examples from his brush are to be found in the collections of the late Prince of Monaco and in many other art collections in Europe, America, and Japan.

Dredging off the Continental Shelf.—Dr. Roy W. Miner, curator of lower invertebrates, American Museum, spent a part of the summer at the Harpswell Laboratory on Mount Desert Island, Maine. In company with Dr. Ulric Dahlgren, the director of the station, he made dredgings at the edge of Frenchman's Bay on the continental shelf, in water attaining a depth of about thirty fathoms. With the material scooped from the ocean bottom it is Doctor Miner's intention to construct an exhibition group of *Terebratulina*, in which in addition to these hinged lamp shells there will be shown the representative marine forms such as sea stars, actinians, sponges, and ascidians, that share possession of the dim depths of the ocean with them.

Doctor Miner was accompanied by Mr. Chris Olsen of the Museum's department of preparation, who made sketches of the forms obtained with special reference to reproducing them as models. In addition to Doctor Miner another member of the scientific staff of the Museum, Mr. Frank J. Myers, research associate of Rotifera, availed himself of the facilities offered by the station for investigations. He made studies of the pond life of Mount Desert Island, with special reference to the rotifers. About 250 species of rotifers, including twelve new to science, were recorded.

Unusual opportunities are afforded the student of marine life at the Harpswell Laboratory, as set forth in an article that Doctor Miner contributed to the issue of Natural History for January-February, 1922, pp. 46–55. Ten research rooms and a library of more than 2000 volumes are given over entirely to investigators working in their chosen subjects. The equipment includes salt-water aquaria with cold fresh sea water. A collector is attached to the laboratory whose duty it is to secure the animal and plant forms that may be required. For sea-going purposes there is a gasoline boat with equipment for collecting in deep water. During the past summer the staff of the laboratory started a biological survey of the waters about Mount Desert Island.

CONSERVATION

Saving the Redwoods of California.—A signal triumph has been won by the Save the Redwoods League of California in the passage by the Legislature of that state, and the signature by Governor Richardson, of the Bill introduced by Assemblyman Rosenshine and warmly sponsored by the League and its officers,—John C. Merriam, president, Joseph D. Grant, vice president and chairman of the Board of Directors, Robert G. Sproul, treasurer, and Newton B. Drury, secretary. Under the terms of that Bill the state board of forestry is authorized and directed to undertake a survey of the state forest lands with a view to designating those suitable for conversion into public parks. Control will rest with this body to acquire wooded land within the selected areas "either by gift, donation, contribution, purchase, devise, or proceedings in eminent domain." Through this far-reaching measure it will be possible to acquire tracts of great beauty and interest for the enjoyment and inspiration of the citizens of California and visitors to that state.

An instance of the practical operation of the Act is supplied through the recent gift of Mrs. Zipporah Russ, who has set an example for

other public-spirited citizens to follow in presenting to the state of California an unusually fine tract, 166 acres in area and containing 30,000,000 feet of redwood in addition to other timber. The tract is given in memory of her husband, Mr. Joseph Russ, a pioneer of 1852, as a memorial to the pioneers of Humboldt County.

THE WILD FLOWERS OF NEW YORK STATE.—Everybody loves the wild flowers but in our thoughtless acquisitiveness we are endangering many species. When we pluck a flower, we rob it of its opportunity to mature its seed and so to perpetuate itself. Thornton W. Burgess in his recently issued *Flower Book for Children* tries through that amiable fellow student Peter Rabbit to restrain the child from destroying the bright flowers that attract him. But adults too need restraining, and laws are necessary to supplement teaching. Several states already have laws forbidding the plucking of rare and interesting plant forms; it is with the hope of enrolling New York among the states enforcing such restrictions that at a recent joint meeting, of the Torrey Botanical Club, the New York Bird and Tree Club, the American Fern Society, and the Wild Flower Preservation Society of America, a committee was appointed, of which Dr. G. Clyde Fisher of the American Museum is a member, to draft a Bill for consideration by the New York Legislature, to the end that some of our state plants that are in danger of disappearing may be preserved for the enjoyment and interest of future generations.

Since the last issue of NATURAL HISTORY the following persons have been elected members of the American Museum, making the total membership 7090:

Life Members: MESDAMES DOROTHY RYLE DE BERNARD, JOHN HARDEN DORN; MESSRS. LOUIS BAMBERGER, GUY CARY, ROBERT GOELET, AND GOODHUE LIVINGSTON, JR.

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The LIBRARY, comprising 100,000 volumes, is at the service of scientific workers and others interested in natural history, and an attractive reading room is provided for their accommodation.

The POPULAR PUBLICATIONS of the Museum, in addition to NATURAL HISTORY, include Handbooks, which deal with the subjects illustrated by the collections, and *Guide Leaflets*, which describe some exhibit, or series of exhibits, of special interest or importance, or the contents of some hall or some branch of Museum activity.

The SCIENTIFIC PUBLICATIONS of the Museum, based upon its explorations and the study of its collections, comprise the *Memoirs*, of quarto size, devoted to monographs requiring large or fine illustrations and exhaustive treatment; the *Bulletin*, issued since 1881, in octavo form, dealing with the scientific activities of the departments, aside from anthropology; the *Anthropological Papers*, recording the work of the staff of the department of anthropology; and *Novitates*, devoted to the publication of preliminary scientific announcements, descriptions of new forms, and similar matters.

A detailed list of the publications, with prices, may be had upon application to the Librarian, American Museum of Natural History, New York City